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## EDITORIAL NOTES.

### The Institution Meeting at Liverpool.

APART from the printed programme, one never knows precisely what is going to happen at an annual meeting of the Institution. Preparations, both in the way of technical fare and social entertainment, may be made of the very first order; but then there may come adverse weather conditions tending to mar the arrangements, and damp the spirits of those who attend the meeting. But there was not anything to mar the excellent programme that had been prepared for the meeting in Liverpool last week. The atmospheric conditions were particularly kind; the sun each day being generous with his presence, and, when he was not in prominent evidence, there was nothing whatever of which to complain. The President (Mr. Edward Allen, M.Inst.C.E.), too, throughout the week was as sunny as the weather. "The Happy President" was the description applied to him privately by one visitor. And the description fitted; for it was about the happiest week in relation to his presidential office and functions that Mr. Allen has had during the past year. Mrs. Allen and members of the family—especially his fair daughters—did good service in assisting husband and father in looking after the comfort and entertainment of the lady visitors, and frequently, too, of the gentlemen. They were at the service of all. When away from the business and technical conferences, the cup of pleasure for the visitors was ever full, for the Lord Mayor (the Rt. Hon. Herbert R. Rathbone) and the Corporation were coupled-up with the Chairman (Mr. H. Wade Deacon, J.P.) and Directors of the Gas Company and the President in making complete provision for entertainment. They were all as generous as the weather; and hosts obviously derived as much enjoyment from their engagements during the week as did their guests, who have taken from Liverpool to their homes many happy memories.

Turning to the proceedings at the business meetings, it must be said that, had it not been for the brilliant lecture by Mr. Charles Carpenter, D.Sc., on "Purification by Heat" (which is discussed in a succeeding article), the remaining contributions, taken as a whole, would not have made the occasion conspicuous in point of technical merit. The investigations that are proceeding at the Leeds University, and upon which reports were made at the meeting, are all in nascent state at the moment. This is not the fault of anyone. But it was the loss of this meeting that time has not permitted the maturing that would have allowed of something conclusive being presented as a result of investigation. But this can be said, that the reports presented by Mr. Harold Hollings, B.Sc., on the thermal phenomena of carbonization, and by Mr. William Harrison on ventilation problems (both of whom are working under the direction of Professor John W. Cobb) promise to be productive of much interest, and, it is hoped, of practical value. There is room for a thorough investigation of the temperature changes that occur during the distillation of coal, and of the heat absorbed or evolved during the process. Enlightenment is also required as to the influence of incandescent surfaces and radiant heat on the decomposition of ammonia, and as to other kindred subjects. There is a disposition to sneer in some quarters at the small-scale operations of the laboratory, and to refer to them as being valueless in their lessons, through being so far removed from actual working-scale operations. But knowledge and progress, more especially in the gas industry, are inseparably bound up with the investigations of the chemist; and, as Mr. Carpenter said in the course of his lecture on Wednesday morning, the man who deals with tons cannot to-day do without the man who deals with grains. The one is necessary to the other. We do not feel quite so sure about the value that will be derived from the ventilation research, though we cannot see any help from doing other than conduct the inquiry under standard conditions. The objection is that inflexible standard conditions, with air ingress and egress fixed, and currents moving in a single direction only, have not anything in common with everyday conditions; so, that, whatever the findings under the standard circumstances, there can be no application of them as being representative of ordinary conditions. It would perhaps be useful to adopt the suggestion made by Mr. Jacques Abady, and to make parallel tests in a room which could be regarded as possessing the common attributes of a room in a dwelling-house. The report presented by Mr. Harold Hartley, M.Sc., treating of the electrical condition of a gold surface during the absorption of gases, and their catalytic combustion, has an appearance somewhat foreign to a meeting of gas engineers. But as Professor Bone says, it brings us face to face with an important fundamental question; it being very desirable now to find out much more of what is behind the chemical combination and affinity of gases.

The report by the Refractory Materials Committee—which was presented by Mr. F. J. Bywater—makes another useful contribution to the subject. The work of the Committee is one of a progressive and watching nature; and it is foolish to imagine that this work could have been taken in hand and completed with a clean finish within a brief period. It could only possibly be done, so to speak, piecemeal; and there is yet plenty for the Committee to do, particularly if members of the Institution will help them by sending information as to experiences and unusual occurrences. The report this year makes an interesting contribution to the subject of the use of silica material for retort settings; the inquiries of the Committee in America having brought to hand some serviceable information as to the use of 95 per cent. silica material. If, however, Mr. J. W. Morrison's experiences at Sheffield may be taken as a guide—and we see no reason why they should not be, seeing that he has been using large quantities—then material containing 85 per cent. silica is preferable to that containing 10 per cent. more, owing to the soft state of the latter under carbonizing temperatures. The work that Dr. Mellor has in hand in investigating the melting-points of refractory materials under pressure has already given surprising results—inasmuch as the experiments show the melting-points, under laboratory conditions, lowered from the normal by as much as 12 or 13 per cent., when subjected to a load of 54 lbs. per square inch. It would not do, however, to deduce from this that the same lowering of the melting-point takes place under the pressure brought to bear upon the refractory material composing retort-settings; and the result of the laboratory experiments suggests that there would be interest in transferring the investigation to a retort-setting.

The cause of education in the gas industry has always had in Sir Corbet Woodall a zealous champion; and the principles in which he believes in this regard are carried into practice in the Companies with the administration of which he is associated. Sir Corbet was the Institution's Jubilee President; he was also to the fore, as Governor of the Gas Light and Coke Company, in the centenary celebrations of the foundation of statutory gas supply in this country. These events will henceforth be associated with a generous act concerning which it was the privilege of the President to make announcement during the opening sitting of the Institution last week. It was to the effect that Sir Corbet is desirous of providing the necessary sum of money for the foundation of a travelling studentship in the Technical University Departments in our own country, or else a scholarship at one of the Continental Universities, of £50 a year, to be awarded annually under certain conditions. The generosity of Sir Corbet was much appreciated. Another announcement related to that long-discussed proposition of providing a permanent home for the Institution, which from its birth has ever been a sort of vagrant. The time never has been, and never will be, propitious for doing this, with things continuing as they have been. Money has

always been an obstacle to the setting-up of a permanent home; and lump sums such as would be required for the purpose do not fall haphazardly from the clouds. The desire for a permanent home is quite a legitimate one; and as money cannot readily be obtained to gratify the desire, the only thing to do is to "save up." The Council have, therefore, allocated £500 from the Institution funds to a special fund for the purpose; and it will assuredly be the ambition of every future President to see this nucleus grow during his year of office.

Though technically there was a little weakness in some parts of last week's meeting, there was not an item that did not interest; and the lecture more than counterbalanced any shortness of technical weight in the papers. On the social side, the meeting was a glorious success. The energy of Mr. Allen during the year, and his self-sacrificing devotion to the duties of his high office, supplemented by his personal qualities—his kindness, courtesy, and loyalty—have gained for him an intensified affection in the ranks of the profession. He has been a model President. Though perhaps there will not be so much demand upon his successor in the chair this presidential year (there will be no National Gas Exhibition), the work of the industry extends, and so do the duties of the Institution; and therefore, even in normal times, the claims upon the President are greater than formerly. Nevertheless, in the hands of the new President (Mr. John Bond, of Southport) the work of the Institution will not suffer; and we are confident that the dignity of the organization will be upheld, and its usefulness advanced. We sincerely hope Mr. Bond will have as much success in office as his predecessor.

## The Presidential Address.

Throughout his year of office, the President has not, in his public addresses and speeches, been extravagant with time, nor a monopolizer of it. Patently he does not believe in a man who has the audacity to think that there is only one seat of wisdom, that he has been providentially singled out as the individual in which to establish it, and that therefore, by right of the distinction, he is at liberty to engage the attention of an audience as long as he pleases. Such egotists are usually bores of the first water. Mr. Allen has a ready wit and tongue which he tempers by brevity; and it is quite foreign to his nature to be an egotist or a bore. His natural inclination was reflected in his Presidential Address. It was condensed to such a degree comparatively with Institution precedent that the President did not claim the attention of the members for any great length of time. In point of fact, they would have preferred to have heard more from him; and it is probable that, notwithstanding his disposition, he would have given them somewhat more had the time at disposal for preparation been of a more liberal character. But a President following Sir Corbet Woodall in the chair; with, too, a National Gas Exhibition in front of him, and, on its consummation, putting in practically a whole month's attendance thereat in lieu of a summer holiday; with a Bill in Parliament involving much preliminary negotiation with ultimate contest at Westminster, and succeeded by arrangements for the purchase from the Corporation of their gas-works; giving presence during the year at many of the meetings of the District and Junior Associations and those of the Society of British Gas Industries, and at Council meetings of both the Institution and the British Commercial Gas Association; and taking large personal part in making the arrangements for the present annual meeting—well, with such devotion to the claims of his office, the marvel is how time was found for the preparation of a Presidential Address at all. If anyone has worked hard this year, it has been the President; and if one week out of the fifty-two of his presidency can be described as the pleasantest of all, it was last week; but the responsibility of it must have made it one of the hardest.

However, there was a Presidential Address, and one that was suggestive rather than industrially or technically retrospective, introspective, critical, or a certificate of strength and of good character. It was a plain, unpretentious address; and yet its very plainness was in parts an eloquent appeal, from a very humane nature, to make the best of, and do the best for, the human units of the industry whose social position and educational opportunities have not conferred upon them such advantages as others possess and can command. We feel almost tempted to base our introductory comments on this side of the deliverance; but this would not be fair to the President's own choice of the sequence of topic. No one in his position as Chief Engineer and Manager of the Liverpool—the largest provincial—Gas Company could prepare a Presidential Address for delivery before a body of gas men assembled at the great North-Western seaport without referring to the work of his two predecessors in the engineership, Mr. Alfred King and Mr. William King—the former having done much pioneer work for the industry, and both having contributed largely to the building up of a strong technical and commercial position for the Company. We do not think the Liverpool Company and executive officers have ever had all the credit that they deserved for what they have done in helping the progress of the industry; but the blame for this must be placed at the account of an undue reservative policy in times past, but not recently.

Passing from home matters, the President found himself confronted by some little difficulty in discovering the material for giving an account of the technical progress of the presidential year. Of course, the difficulty depends largely on what is meant by "technical progress." If one only includes in it new fundamental improvements, then there has not been anything to record during the year; but if one means the advances made in enhancing the modern types of plant through details, then good work has been accomplished, as can also be said if one looks at progress from the point of view of the application to work of the more modern developments. There has, in fact, been a great deal of this progress, as the contractors can testify. Of course, we cannot expect radical advance every day in an industry such as this of gas manufacture, distribution, and use; and with such advances, time is essential to progressive application. The heat purification system of the South Metropolitan Gas Company (which was the main feature in Mr. Charles Carpenter's lecture at Wednesday's sitting) is not a product of the year; but the President put it at the head and front of his technical review. In the course of the year, however, progress has been effected in the economy of its application and working, and considerable installation has been made at the works in South London. There is nothing fresh to say about carbonizing plant. Its progress during the presidential year has also been in the way of extended application of the modern systems; but otherwise fresh ground has not been broken. The President finds himself much in the same boat as many others. It is one of the most difficult things imaginable to-day to construct a case of absolute superiority in the matter of profit for one or other of the systems—whether horizontal retorts, worked from one side of the bench only, and with heavy charges, or vertical retorts of the various descriptions. All have their individual good points; and application to-day is frequently settled by the character of the products required. It is quite true the horizontal retort is far from that position when it will be removed by the simple process of the exhaustion and displacement of those now in existence. New horizontal retort houses will still go up; extensions and replacements of existing horizontal settings will continue to be made. But gravity charging and discharging, the smokeless and steamless retort-house, the dry quenching of coke, the conservation of the heat of the incandescent coke, the reduction of the naphthalene trouble, have their charms. But here we are in 1914 in the quandary that judgment of the systems cannot be made in a manner that will apply to all cases, without reference to local circumstances—these circumstances, remarks the President, "being sufficient to turn the "scale in favour of one system at one place, and of another "system in a different place." The President did well to lay stress upon the movement towards a more critical supervision, and amendment in detail, of the condensing, washing, and scrubbing plant. This movement is very necessary, in view of the effect on gas quality, purifying material efficiency, and ammonia recovery.

The President did not say anything about the applications of gas, except incidentally when dealing with legislation; and here, had he chosen, he could have dilated at some length upon a change that has taken clear form. If we cannot claim to have made during the year any radical technical progress in gas manufacture or application, the current parliamentary session marks, through the settlement of the conditions of a calorific standard and test, a change that opens up the more it is examined a broader and broader prospect in regard to gas application. Here the President brings out a point of which sight is largely lost in the more general consideration of the question of the propriety of transferring

the qualitative standard of gas from illuminating power to calorific value; and it is that the imposition of a universal calorific standard would (there are, of course, certain reservations) contribute to the ability to produce, and to adopt throughout the country, standardized gas appliances of maximum efficiencies. Anything that contributes to this condition will be welcome; for it has to be confessed that consumers generally are not in the habit of regulating their burners to obtain the highest efficiencies, with the result that there is a considerable amount of wasted efficiency through the neglect. The only means of counteracting this is, in the first place, the establishment of a uniform quality of gas, so that appliances when once regulated will give continuously an efficiency fairly approximate to the best. But a standard calorific power will not alone do this. Pressure, density, and constitution are factors; and these cannot be left out of account. Furthermore, the advantage of having the standard of quality based on calorific value is of a polyphase order; and this is emphasized by the President when he points to the facts that relief from the illuminating power standard enlarges the field for coal supplies, and makes it possible for gas undertakings to have a greater selection of carbonizing methods, with a view to reducing the costs of production. There can be no doubt that a calorific value standard spells economy. And, while we are strongly opposed to the margin between standard and penal line being drawn too closely, there is a fair amount of assurance that the new conditions will operate to prevent what we know is a result of some extraordinarily high "makes" of gas at the present time—the presence in the gas of an undue proportion of inert constituents to the detriment of consumers. But, generally speaking, the policy of the industry is, as the President puts it, "the greatest good for the greatest number;" and this "policy is not only justified, but demanded in the interests "of the public." These last phrases are of the many that stand as gems in this all too restricted address. Such phrases oftentimes carry more weight and conviction than a mass of argument, the point of which is not carried home with the same directness.

Similar philosophic thought pervades the views of the President when dealing with that part of the human element of the industry composed of the artizans and manual workers. The President is one of those who possess the deep conviction that the industry's human element, in all its various grades, requires, in order to obtain and to maintain its highest efficiency, the same consideration and attention as brainless and involuntarily acting machinery and plant—not only in first training but afterwards. Only in this way can the high-water mark in the diverse operations of a gas undertaking be worked to. It is sometimes forgotten by those placed in power over the rank-and-file that every constituent part is of the same flesh and blood as themselves. The difference is largely in social station and opportunity—not always in ability. Ability sometimes lies dormant in the most unexpected places; and it is the duty of officials to do all that is requisite in developing ability throughout the ranks of those below them, in order to realize the best possible for the whole undertaking. In the matter of reward, there must also be distinction according to ability. Proper provision should likewise be assured for recreation. The President emphasizes this; but in the same breath he cites the light-hearted philosophy of R. L. Stevenson on the subject of industrial work: "Industry is in itself, and when "properly chosen, delightful and profitable to the worker; "and when your toil has been a pleasure, you have "not earned money merely, but money, health, delight, and "moral profit, all in one." There is much truth in this; and it is good policy to attain as nearly as possible to the ideal presented there in the provision and the methods of work. But if the work were generally productive, under the ruling diversity of human nature and temperament, of all those beneficial effects, then why the necessity of talking of super-recreation, rates of pay, trade unionism, and so forth. The work itself would produce absolute contentment. But practical experience rudely shakes the foundations of such industrial ideals; and something supplementary to the work is necessary—not only fair rates of pay, but something that promotes and sustains interest in the work. In co-partnership, the President finds the complementary part to the work provided and the wage paid. But in the consideration of wages, he shows himself to be no advocate for raising them to a point much in excess of the rates obtaining for similar work in the locality, though just as strong a believer in the law of a living rate of wages which has, in regard to labour, supplanted the one relating to supply and demand. He has a reason for his view, regarding the point as to local rates of pay being applied to the gas workers. The gas industry draws a considerable part of its income from the outside workers; upon their patronage and extended patronage gas workers depend. The economical supply of the outside worker has to be studied; and this economical supply must not be unduly interfered with by a too extravagant consideration of the gas worker. Herein we have broad-minded views on behalf of the workers beneath the chief official, tempered by consideration extending to their equals beyond the gas-works gates. These are views not of a narrow-minded politician, but of a statesman of the imperial order. The address is not one that must be dismissed with a glance; in respect of the parts upon which we have commented there are veins of wisdom and thought in it that claim serious contemplation, and which will serve to guide in administrative policy.

## Means to the Ideal in Purification.

The lecture on purification by heat, and the lessons of a century's progress, that Mr. Charles Carpenter, D.Sc., delivered at the meeting on Wednesday morning, partook of the character of the lecturer himself. If we look back over the work that he has done in connection with the gas industry, we see it initiated by high ideals; we see, too, how he has set to work to discover, with the aid of his staff, practical means for arriving as close as possible to his objective; and we know well of the valuable successes. At the close of the lecture, thoughts and ideas were running riot in the minds of those who had heard the deliverance. All present were immediately of one accord that the lecture—its objects and the method of treatment (which was as thorough as the latter-day purification work described)—was the masterpiece of the conference. But the minds of many present were oscillating, and could not come to any definite bearing, as to whether there was really anything more in it all than the fancies of the idealist, with the idealist in the happy position of having found a practical way of attaining as closely as has yet been done to the vision of a supply of gas which, in its combustion, emits nothing more than the human being through respiration—carbonic acid and water-vapour. This is a matter for admiration. But this particular idealist, as thoughts run on, is found to be a very difficult person indeed to push off his perch; for his perch has in front of it a wonderful barricade of figures, obtained not from laboratory experiments, but from a $1\frac{1}{2}$ million plant, then from a 10 million plant, and now from a third plant of no less than 15 million cubic feet capacity, and an experience, under working conditions, extending over the past two or three years. There are the figures from this work—figures attesting beyond dispute to percentages of sulphur reduction never reached in ordinary purification practices, and at a cost rather below $\frac{1}{8}$d. (to be exact, 0·299d.) per 1000 cubic feet, including interest, depreciation, &c. There is no use summarily dismissing a man and his work who fortifies himself in this way against all negation, and therefore what he has to say must receive careful and respectful consideration. When this has been given in the present instance, we think it will be generally conceded that Mr. Carpenter is right, and that those who think that his views are in excess of requirement are wrong.

Let us start at the end of the lecture. There we find Mr. Carpenter saying: "I am strongly of opinion that irritating "restrictions as to sulphur impurity are unnecessary." It is well to make this point first; seeing that there are gas men who think that the lecturer of last Wednesday is now on the highway to the undoing of the relief to secure which the South Metropolitan Gas Company—with Sir George Livesey as leader, and Mr. Carpenter as his lieutenant—headed the fight. The very position of the purification question as presented from Old Kent Road is only an illustration of what has happened in the past (and the Legislature might make note of it) in connection with the gas industry—that all big advances, to the mutual benefit of the consumers of gas and of gas enterprise, have been made external of legislative restriction. By observing Mr. Carpenter's point in regard to restriction, readers will at once get on to good terms with him, and the more readily pay heed to his argument for realizing, without compulsion, the highest attainable purity for gas supply in regard to sulphur, so long as practicable method permits. The philosophic

warn us that the highest efficiency in any walk will never be reached by those who adopt as their maxim that a thing or method is "good enough." There is to-day a disposition in the industry to say, as to the sulphur purity of gas, that it is "good enough," and to adopt this as a sufficiently clinching argument against those who, like the lecturer, maintain that duty ought to have a higher ideal, and an energy to endeavour to reach a higher plane, so long as injury is not wrought in other respects. We know well enough that investigation has shown that, while the sulphur content of gas is no higher than (say) 40 grains per 100 cubic feet, there is nothing noxious about it; but we also know that, if the sulphur content is only half this quantity, the gas is all the better, and, if it can be reduced to 7 or 8 grains, then it is better still. We cannot deny this. We cannot deny that while incrustations form on metal work, or injury, though slight, be committed in any other way, through the quantity of sulphur remaining in the gas, the supply is not all that could be desired; and that it would be intrinsically better if the condition producing the harm could be removed. Nor can we assert that the maximum of refinement in the purity of gas is not, in the face of competition, in the best interests of the future of the gas industry. To flout conditions that common sense tells us are the best is not an act of prudence. To speak of a higher refinement as a work of supererogation, if the refinement can be attained on economical lines, and for which refinement it would be to the advantage of the consumer to pay, is to reject foolishly a factor that will make for the strengthening of the competitive position of the industry in the future. To set ourselves up against obvious common-sense truths is absurd. It may be said that the lighting load for which a higher refinement is claimed by Mr. Carpenter is only a certain percentage of the whole supply; but lighting is still the backbone of the industry's business, and gas used in other directions would not be any the worse for having its sulphur content reduced to the lowest practicable limits.

No stable argument can be found that will enable one to get away from the point. It is, there is no question, absolutely true (as proved by the South Metropolitan Company), that the exposed plaster of our ceilings and walls has a purifying effect upon the air in gas-lighted rooms, and that gas, if properly used, is an important aid to ventilation. But it was never intended that the plaster of ceilings and walls should be an adjunct of gas lighting; it is only a fortuitous circumstance that it is so. Therefore it all comes to this, that if an economical purification system is available, by which the sulphur content of gas can be lowered as it has never yet been lowered, then the system deserves universal consideration. Such a system Mr. Carpenter introduced to the meeting; and he asked those present to consider it in the light of the future, and not merely of to-day. The question is not only one of economic importance; it is one of protective importance. But it is the economic side, combined with efficiency, that will at the present time have the greater weight with the professional men of the industry; and on this head the system as practised at the works of the South Metropolitan Company invites attention. There is no necessity at this time of day to explain the catalytic process by which there is decomposition of the carbon bisulphide, and the removal by the ordinary means of the resulting sulphuretted hydrogen. There have been other workers in the same field as the South Metropolitan Company; gas purification by heat processes has been among the ideals of men as long almost as the gas industry has existed. But no one did any good with the suggestions till the Portland (U.S.A.) Gas and Coke Company developed the Hall and Papst system, and got a large percentage reduction of sulphur, but under intermittent and not continuous heat conditions, and, it is feared, a depreciation of the qualities of the gas. The South Metropolitan Company were at work at the period that the Portland system was brought into action; and the system that has been developed by the technical staff of the former, after much hard work and disappointment, has surmounted the obstacles and difficulties of all previous work. The process is a continuous one; the catalyst—balls impregnated with reduced nickel, obtained by a reduction of the chloride in a current of hydrogen—has had its efficiency and longevity, with periodical cleaning from the gradually enveloping carbon, fully proved; and the preheating of the gas by the method developed has made of the system a complete success. Mr. Carpenter was both generous and just in recognizing that inception and development are largely due to Mr. E. V. Evans, Chief Chemist of the Company, while Mr. C. F. Franks, Engineer of the Bankside station, is responsible for many of the engineering details associated with the new process. But both Mr. Evans and Mr. Franks, on their part, would as candidly acknowledge that the brains of their Chairman and of the Company's Chief Engineer (Mr. W. Doig Gibb) have played no small part in the development. When we look, too, to the money spent over the work, and over the proving of the process on the working scale, and to the confidence certified by plants respectively of 10 and 15 millions capacity, there is no doubt as to the seat of encouragement and of bold enterprise, for which results declare a complete justification.

Look at the figures. The East Greenwich plant shows a reduction from 35·07 to 7·82 grains of sulphur per 100 cubic feet, or a percentage reduction of 77·7; and the Old Kent Road plant a reduction from 39·74 to 8·22 grains, or a percentage reduction of 79·3. The percentage reductions depend on the amount of sulphur in the gas before treatment, as witness the East Greenwich 77·7 per cent., which is lower than for the Old Kent Road plant, though the East Greenwich gas shows 7·82 grains in the finished gas, compared with 8·22 grains in the Old Kent Road gas. The refinement produced is beyond all cavil. Is South Metropolitan gas containing 7 or 8 grains per 100 cubic feet a superior gas to that which contains 35 to 40 grains? To put the question is almost absurd; to reply in the negative would be extremely so. Yet we cannot say that the 35 to 40 grain gas before treatment was bad; but the other gas is, we will not say infinitely better, but it is better to the extent that the sulphur content has been reduced—that is, to the altogether negligible quantity of 7 or 8 grains. When the whole of the Company's output is under treatment, this will be about the average in the gas supplied by the South Metropolitan Company. Now at what cost is this being realized? The capital cost, including concrete foundations, is about £1500 per million cubic feet; and the working cost, including 10 per cent. for depreciation, interest, &c., is only 0·299d. per 1000 cubic feet. There is the point to be considered as to throwing additional work on the purifiers. On the evidence of the figures, however, as presented, the process appeals from both the point of view of efficiency and of economy. Is the extra expense worth the additional purity? We cannot find any reason for saying it is not—not even when, as in the case of the Dessau retorts at Sunderland, the sulphur content of the gas is about one-half what it is when produced in horizontal retorts. On the contrary, we think that it is; and that it is another step towards one of the ideals of the lecturer—the placing of the gas industry in a stronger and more impregnable position than even that which it occupies to-day. He has gone, with the staff of his Company, from ideal to practical realization, so far as the means have been discovered for securing realization.

Nothing more than the lecture can be needed to induce other engineers to pursue inquiries. Among other things that they will desire to know is how to proceed if they wish to adopt the patented process. Mr. Carpenter, in effect, said: "Here is the process by which we are accomplishing "a higher refinement, without detriment to the lighting "and heating qualities of the gas; now take it or leave it, "whichever you think is best in the interests of your under-"taking." This means that there is no intention of keeping the process for the South Metropolitan Gas Company alone. But there is no information available as to its commercial development. Of this, however, we may be sure, that those interested in the process, whatever the method adopted by which to enable it to be dealt with from the commercial side, will not have extravagant views as to their reward. That they deserve reward for their patient and zealous work in realizing success will be conceded by all.

## Papers and Discussions.

BRIEF comment will suffice for the papers and discussions on this occasion. Although the papers were restricted to four, the topics not afflicted by abstruseness or complexity, and the length not appalling, with also two of the authors—Mr. B. K. Schieldrop (of Bergen) and Mr. Jacques Abady—giving admirable summaries of their communications, they were again pushed up into a corner, and suffered in consequence the want of proper discussion. By the time the third paper was reached—that by Mr. G. T. Purves—there was barely time for more than a few passing references to it; and when Mr. John West had concluded reading his paper, there was no time at all available for its discussion.

This was not by any means the fault of the President, who publishes a letter on the subject in our columns to-day. The difficulty is to make an accurate estimate of the amount of material that can be conveniently brought into three sittings, together with the utter impossibility of ascertaining beforehand how much time will be required by each of the different items composing the agenda. Before the event, oratorical performances are altogether unknown quantities. In view of the fact that certain of the reports were of a purely preliminary, and not of a conclusive or final, nature, time might have been saved by taking them as read. However, the papers, with the value they possess, are now on record; and there is no reason at all why they should not still be discussed. Any of our readers who desire to make remarks upon them can have the opportunity of doing so through the columns of the "JOURNAL;" and it would not be at all a bad thing for the papers to be introduced for discussion at District Association meetings. There would probably be fuller and freer discussion there than, had time permitted, there would have been at the Institution meeting.

The contents of the papers are outlined in the "Review" of the Proceedings" in other columns. With the exception of Mr. Abady's paper, three of them dealt more or less with either coke or sulphate of ammonia or both. Mr. Abady's communication was a statement on the position of the adoption of calorific value as a standard of quality for gas. The principal point considered, as a result of the paper, was the one as to the application of a uniform standard. The author is against this, on account of variable local conditions; the President is for it, considering that, the greater the uniformity of standard, the better will it be for the makers of gas-using appliances to design them so as to secure the highest efficiencies throughout the country. But, as Mr. Abady points out, uniformity of the calorific standard only goes part of the way towards that desirable consummation for which the President so devoutly wishes. For realization there must also be a universal constitution of gas; and this is not economically possible having regard to the variations in coal supply and carbonizing methods. But there would not be any objection to a uniform calorific standard if it was fixed sufficiently low to meet all local conditions, and a margin allowed, to cover all contingencies in working. If a standard of, or higher than, 540 B.Th.U. gross is fixed, then the margin of 7½ per cent. ought not on any account to be reduced. With a standard of 550 B.Th.U. gross, the President finds that a margin of only 5 per cent. in his case is not economically the best. On the other hand, there are those who, if a minimum standard were fixed low enough, would not object to the sacrifice of the margin, as a fixed standard would be more in consonance with the actual object of a standard. But in this matter, at the initial stage of the formulating of a standard and testing conditions, it is well to bear in mind the necessity for keeping something in hand to supply a little elasticity in order to work to provide consumers with the largest number of B.Th.U. for a given price. The parliamentary authorities who will consider the calorific standard for every undertaking, if they follow the advice of the Board of Trade and competent experts, will do well to remember that they may be doing an economic injury to the consumers by fixing the standard in any case too high; and they may depend upon it that, faced by strenuous competition, the gas-supply authorities will see to it that they do not distribute gas that will cause dissatisfaction among their customers. Competition is a stronger force than parliamentary enactment.

Turning to the other papers, there is not a gas undertaking in the country that is not interested in coke more to-day when the markets are strained with the supply than at ordinary times. We are not in the comfortable position described by Mr. Schieldrop, of our friends in Norway, where, through the domestic heating customs of the country, the home gas-works can only produce sufficient coke to meet 30 to 40 per cent. of the demand, and so have to import the remainder. It is an enviable position. But the custom of Norway is never likely to be the custom in this country. Our own domestic coke producers, however, can do much to make the commodity more suitable than at present for developing a domestic use, by the cooling of spent retort charges—by the "Dryco" or some other system, such as that obtaining with the continuous vertical retorts—so that the coke does not contain a large thermal depreciating percentage of water, and so that its physical structure is not impaired as it usually is by quenching in the ordinary way. The coke question was also raised in connection with the paper by Mr. Purves on the utilization of coke-ovens, with direct ammonia recovery, for gas-producing purposes. Mr. John Young called attention to the fact that the metallurgical coke market is as much overdone by supply now as is the gas-coke market. But this fact hardly comes into the argument for or against the application of coke-ovens to gas-works purposes. The primary consideration in the adoption of coke-ovens by gas-works must be the local demand for foundry coke. But, as Mr. W. Chaney pointed out in his paper last year, by the coke-oven plant at Birmingham they are quite able to make metallurgical coke or a coke quite suitable for the same purposes as that for which ordinary gas coke is used. It all depends upon the treatment of the charges.

We come to sulphate of ammonia—a market that is at the present time receiving much anxious consideration. It is essential that sulphate of ammonia shall be produced as cheaply as possible, and as much realized as possible from a ton of coal, in order to meet the competition from other sources. The average production last year in the case of the coke-oven plant under Mr. Purves' care was 36 lbs. per ton; and the direct system of recovery, it is known now, is a more economical one *per se* than the ordinary practice of gas-works. But we want to know more about auxiliary costs as affecting the application of the direct-recovery system to gas-works. It is necessary that a balance-sheet should be made out, covering everything from the retort-house to the station-meter, in order to show precisely how in a gas-works direct recovery of ammonia would affect costs and workings between the two points, as well as more information as to the resulting quality of the gas. As to quality, Mr. Purves states that the light tar oils are preserved in the gas, and so add to its value; but what Mr. Purves says on the question of costs, on this point of quality, and on the stability of the light tar oils, is not sufficiently comprehensive.

As important as a reduction of costs in sulphate of ammonia production, and as a large yield per ton, is the sale of the product—in fact, it is more important, as demand governs market price. Mr. West's paper is one that should be distributed broadcast among farmers, as, if the experiences recounted there were in their possession, many more of them would, we think, unhesitatingly endeavour, by the described means, to secure the profitable advantages. If farmers all did as is done with sulphate of ammonia on the farm with which Mr. West deals in the paper, he asserts that the demand for the fertilizer would increase tenfold. Then what a happy position our home gas-works would be in—if the extraction of nitrogen from the atmosphere did not result in fierce competition for a controlling supremacy in the market. However, Mr. West is anxious the home trade for sulphate of ammonia should be much more strenuously cultivated, and the land of this country made much more profitable. One way of bringing this about might be by entering into better trading relations with the farmers. They are people, for instance, who can do with a little credit; their revenue only coming in with the reaping of the harvest. It is a good paper that Mr. West gave to the meeting; we are more than sorry, in view of the position of the sulphate of ammonia market to-day, that there was not the time available to discuss it.

## Waverley Presidential Address.

It cannot be said that there was any dearth of material for discussion at the last meeting of the Waverley Association. The address prepared for the occasion by the President—Mr. W. S. Easson, of Jedburgh—really supplied material enough for several discussions, a large part of which would doubtless be criticism of several of the points raised. Take, for example, the comparative figures put forward as to the cost of various illuminants. In the first place, a figure is named for petrol air-gas lighting which is more to the advantage of the system than it is entitled to. Mr. Easson says that with petrol air-gas an 80-candle power light can be obtained for 5·6 hours for 1d. But in this calculation he only takes the cost of the petrol, and does not include anything for interest and depreciation charges on the plant required, nor anything for labour, even assuming that the other items constituting a charge on the user are the same as in the case of gas and electric lighting. The cost of the petrol gas itself we do not find is quite what the President represents. The petrol that he prefers for use in the comparison he prices at 1s. 10d. per gallon. Suppose he makes a gas containing

2 per cent. of petrol vapour, the gallon of petrol will only produce 1400 cubic feet of gas; suppose he makes a gas containing 6 or 7 per cent. of petrol vapour, only 400 cubic feet of gas will be made per gallon of petrol. With the lower grade gas, a duty of 5 candles per cubic foot may be realized; and with the higher grade 11½ candles. This being so, the poorer gas gives the better return. To obtain 80 candles per hour, 16 cubic feet of gas would have to be consumed; and therefore the gallon of petrol would only last 88 hours, which, divided by the 22d. paid for the gallon of petrol, would result in 4 hours, against his 5·6 hours, for 1d. In considering electricity, Mr. Easson allows an efficiency of 1 candle per watt-hour. There is no reason, with the metallic filament lamps in use, to concede to electricity a higher efficiency than 1 candle per 1·25 watts; and a long course of experiments proves that there are few lamps that have an efficiency higher than 1 candle per 1·3 to 1·5 watts. With coal gas at the high price of 4s. 5d. per 1000 cubic feet, it comes out cheaper than the competing illuminants; but comparison would be still more in favour of coal gas if the figures for the competing illuminants were adjusted to what they should be.

The comparative results of tests that the President gives for coal, anthracite, and gas fires are not very convincing, as the temperature of the air of the room is not by any means the best, or rather only, criterion of room warming efficiency; and certain it is the coal-fire does not and cannot keep up such constant radiation as a gas-fire. The gas-fire is worth something more than the coal-fire if only for its constancy, to say nothing of the freedom from dirt, smoke, and labour; and, for comfort's sake, the less we have to do with anthracite stoves, the better. With gas at 4s. 5d. per 1000 cubic feet, it is not astonishing that Mr. Easson is not an advocate of gas-fires for a sixteen-hour per day consumption; but when he tells us that he found in his experiments that, with gas at 4s. 5d., the gas-fire worked out at an average cost of only 0·5d. per hour, then we are confident we could ensure his advocacy for a sixteen hour per day use with gas at half his price, as it is in many places. At such a price, on Mr. Easson's showing, the gas-fire should be cheaper than the coal-fire or the anthracite stove.

There seems to be much that is old-fashioned about the carbonizing plant and methods at Jedburgh; but perhaps this partly arises from the fact that it is considered impossible to adopt regenerative furnaces on account of the river being so close at hand. If this is the only thing that prevents the President improving on direct-fires, 2-cwt. charges in four-hour runs, and a make of only 10,000 cubic feet per ton, then we would as soon as could be see if were not possible to have a small stage-floor house, and realize all the advantages of heavier charges, a higher make, and lower working costs—that is, providing vertical retorts were not preferred. It seems a bit peculiar to hear of condensing plant being placed *inside* the retort-house, in order to realize gradual and effective condensing. As to purification costs, the President is to be congratulated. The costs work out at present to 0·32d. per 1000 cubic feet; in another year (revivifying *in situ*) they will, he computes, be reduced to 0·16d. Deducting the value of the spent material, he arrives at the net cost—purifying 3 million cubic feet—of 0·05d. per 1000 cubic feet.

This is really such a notable figure for a works of the size of those at Jedburgh that we rather think the estimate will be scrutinized very closely in order to ascertain why Mr. Easson should do so much better than the majority of gas engineers, and equal to the few who stand top in the lowness of cost. We did not notice, in going through the address, any information as to the purity of the gas as sent into the district. Regarding the question of small works entering upon sulphate of ammonia manufacture, this must depend upon the price they can secure for their ammoniacal liquor. If it has not to be conveyed long distances, it may be better to dispose of it than to work up a comparatively small quantity, especially in these days when there are some doubts as to the future of sulphate of ammonia prices. The £12 a ton taken by the President is not, as at any rate present market values indicate, a figure to be relied upon. At the same time, there are excellent sulphate plants now available for small works, which merit larger consideration than they have received.

The address is certainly full of interest; but it looks as though the President has throughout taken the best possible view of things, although not in all cases the most comprehensive one.

### A Challenge of Interest to Gas-Stove Makers.

In our "Electricity Supply Memoranda" this week, there are a couple of paragraphs of special interest to the makers of gas appliances for kitchen purposes. It will be seen that an electrician who has the planning of a café has challenged, on certain terms, the makers of electric-cooking and water-heating apparatus to show that they can financially beat an existing gas equipment in another café. The challenge indicates that the electrician in question has not yet been satisfied that, even under the favourable conditions on which he has been offered electricity—½d. per unit—there is money in the electrical equipment, all things considered, as compared with the gas equipment. If electricity could win, it appears there are several more cafés in prospect for fitting up with kitchen appliances. It is suggested in one electrical quarter that, during the trial run, there should be expert supervision of the electrical equipment—presumably in order to get the best possible out of it. We should also suggest to the electrician issuing the challenge that a careful watch should be kept to see how often the expert supervisor rendered "first aid" to the electrical apparatus in a manner that only an expert supervisor could do. If the electrical apparatus has supervision from an expert, then there ought to be a similar run with the gas appliances, also under expert supervision. It seems hardly fair, too, that spick-and-span electric appliances, before heating elements begin to depreciate, and before the appliances have been subject to the "rough-and-tumble" of the kitchen, should be brought into comparison with apparatus—cooking and boiling—already in use, and which may not show the efficiency of more modern types. There is no invitation on the part of the challenger to makers of gas appliances to enter into this competition; but perhaps some of them would like to obtain the honour—and the valuable advertisement—of coming out victor in such a competition, by offering to take it on for gas on the terms suggested, or such modified ones as might be agreed to by the challenger, to meet any of the views that might be held by the electric apparatus makers.

## THE EDUCATION AND CERTIFICATION OF GAS-FITTERS.

### Joint Conference at Liverpool.

A Joint Conference on the above subject of members of Committees of the District Associations was held at St. George's Hall, Liverpool, last Wednesday afternoon—the PRESIDENT of the Institution (Mr. Edward Allen) occupying the chair. Most of the gentlemen present stated that they had no definite suggestions to lay before the conference, having come there more with the idea of learning what was the general feeling as to the best course to pursue in the education of their fitters.

Mr. E. H. HUDSON (Normanton) said in the Yorkshire district, as soon as they were ready with a direct scheme, they were assured of a satisfactory number of students.

Mr. J. FERGUSON BELL (Derby) pointed out that in a large number of towns there would be a difficulty in getting teachers with the requisite practical and theoretical knowledge. He suggested that they should arrange to have a man to travel from one district to another.

Mr. H. KENDRICK (Stretford) said that the scheme about to be launched consisted of a course of practical and theoretical training in gas-fitting and the use of gas appliances, open to gas-fitters and plumbers' apprentices, extending over at least three years, and divided into three grades. Grade I. would cover the elements of gas-fitters' work and the regulations affecting gas supply; the examination being a written one. Grade II. would include descriptions and models of gas appliances and apparatus; the examination to be in two parts—(*a*) practical, and (*b*) written. The final grade would be of a more complicated character in every respect.

Mr. R. HALKETT (Glasgow) referred to the difficulty of providing teachers for scattered districts. He said that hitherto the making of a wiped-joint had been regarded by the plumber as being entirely his work; but this was a point on which they would have to take a firm stand.

The CHAIRMAN said it had been suggested that a report of the proceedings should be printed and circulated among all the members of the Associations represented at the conference; and this course was unanimously agreed to. He added that it was hoped to have the scheme in thorough good working order before the end of July.

# THE INSTITUTION OF GAS ENGINEERS.

## PROCEEDINGS AT THE FIFTY-FIRST ANNUAL MEETING,

HELD AT

## ST. GEORGE'S HALL, LIVERPOOL.

JUNE 16, 17, and 18, 1914.

## President: Mr. EDWARD ALLEN, M.Inst.C.E.,

Engineer of the Liverpool United Gaslight Company.

## REVIEW OF PROCEEDINGS.

(For full Report see page 896.)

"FULL HOUSES" could have been posted up outside the hotels of Liverpool last week. Large as some of them are, suitable accommodation was difficult to obtain in them by those who had put off till the eleventh and even the twelfth hour what some people had deemed it necessary to do two or three months since. The contribution that went to make the requirement for hotel accommodation in the city much in excess of the normal was provided by the members of the Institution of Gas Engineers and their ladies, whose presence in the city in such numbers (and from all parts of the United Kingdom) was due to three causes—the popularity of the President (Mr. Edward Allen, M.Inst.C.E.), the cordial invitation of the Chairman (Mr. H. Wade Deacon, J.P.) and Directors of the Liverpool Gas Company for the members to visit the city, and the technical and social programme arranged for the visit. When it is mentioned that there were no less than 731 acceptances for Tuesday evening's reception and dance by invitation of the Chairman and Directors of the Company, some 693 for the reception and dance at the Town Hall by invitation of the Lord Mayor (the Rt. Hon. Herbert R. Rathbone, J.P.) and the Lady Mayoress on Wednesday evening, some 549 for the President's invitation to a trip on the Mersey on Thursday afternoon, and 423 for the trip on Friday to Chester and Eaton Hall, it will be seen that Liverpool did something in beating annual meeting records, and in making a very full week for the visitors. The heartiness of the welcome, and the kindly thoughts in the provision of conveniences and entertainment were reciprocated by numbers and by a fulness of enjoyment. On Monday evening, the lounges of the different hotels—particularly those of the Midland Adelphi and the London and North-Western Hotel—seemed to have had complete possession taken of them by gas men and by ladies who belong to the industry by the right of relationship with its workers. At the Adelphi Hotel, after a Council Meeting—for the Council got to work quickly on the arrival of the constituents—the President came into the lounge (where Mrs. Allen had been associating with the visitors), and gave personal greetings to those who had taken up their temporary abode there. We were reminded by the presence of Mr. Henry Woodall that, now that Mr. Thomas Newbigging, D.Sc., has passed from our midst, Mr. Woodall stands as one of the two or three survivors of those who were—not at the preliminary meeting which resulted in the foundation of the Institution, but at the first meeting that took place subsequent to that interesting event, the Jubilee of which was celebrated last year under the Presidency of Sir Corbet Woodall. Altogether the eve of the meeting at Liverpool was spent in making a very pleasant, general *réunion*.

### The Morning of the Meeting.

On waking on the morning of the opening day of the meeting, the visitors were welcomed by brilliant sunshine, which continued for the greater part of the day. The sitting was timed to commence at ten o'clock; and, shortly before that hour, many groups of members were wending their way to the outwardly sombre—and yet in its very sombreness and strength of architectural feature magnificent—St. George's Hall where the meetings were to be held. At the front of the Hall were seen the javelin men in their gorgeous costumes, and with their spears or half pikes, waiting to receive the Sheriffs—this being a day for the sitting of the Assize Courts. Some of the members of the Institution had the audacity to think that this picturesque display was part of a ceremonial opening to their annual session; but, when they found that the entrance to the meeting hall was in another part of the large pile, their minds were cleared of the temporary presumption.

### A Dual Welcome.

The hall was a splendid place for the meeting. But the members who made it a point of honour to be in position betimes (and most of them did so) had a little interval to spend in conversation, and in making inspection of the cartoons displayed to illustrate the lecture on purification by heat to be delivered by Mr. Charles Carpenter, D.Sc., on the morrow. The extensive drawings were splendid ones, and were only of a piece with the thoroughness with which Mr. Carpenter does things, or has things done, in which he takes a hand, and the fine work was a credit to the draughtsmen who produced them. As is customary

at the opening sitting, there were several ladies seated in the gallery—in fact, the line of fair faces extended some two-thirds round the large hall. Shortly before 10.30, the Lord Mayor, wearing his chain of office, arrived on the platform, accompanied by the President, the Chairman of the Gas Company (Mr. H. Wade Deacon), Mr. William King, the two Vice-Presidents (Mr. John Bond and Mr. John Young), the Hon. Secretary (Mr. W. E. Price), members of the Council, a few visitors, including Dr. A. H. Elliott, of New York, and the Secretary (Mr. Walter T. Dunn). There was applause, which was resumed when the Lord Mayor rose, and first expressed his apologies for the delay he had, quite through inadvertence, occasioned. His Lordship, in his speech of welcome, showed a good knowledge of the important part taken by the gas industry in commerce and industry, in promoting sanitary atmospheric conditions for communities, and in contributing to the æsthetic appearance of cities and towns. At the National Gas Exhibition, the heads of other great cities recognized the ability of the industry to combat the plague of the smoke nuisance; and the Lord Mayor of Liverpool—who comes from a family which has done much for the promotion of art, education, and the economic conditions of the people of the city—is not a jot behind those other leaders in civic life who have expressed their honest views regarding the greater sphere in the world's work that the gas industry, all portents now indicate, is destined to fill. His Lordship sometimes lunches in a room from which he can view the house tops of Liverpool; and he is convinced by his survey that the domestic chimney, more so in Liverpool than the factory chimney, is accountable for the state of the atmosphere and the conditions of the houses themselves. In helping to solve the great difficulty of the smoke nuisance, his Lordship hopes the gas industry will not only benefit the people, but will prove that it has not neglected its own interests. The gas industry is much obliged to the Lord Mayor for his beliefs and good wishes in this matter. Then Mr. Wade Deacon, on behalf of the Gas Company, supplemented the words of welcome; reminding, in the first place, that it was 35 years since the Institution previously held an annual meeting in Liverpool. He made a little hit at the work devolving upon the President of the Institution when he said that, judging from the amount of time that Mr. Allen has had to devote to the work of the organization and of the gas industry, the position is a most onerous one. However, there also fell from him hearty congratulations to the Institution upon having a most energetic President; and to the President upon the honour done him by his colleagues. In thanking both his Lordship and Mr. Wade Deacon, the President (who had quite an ovation on rising) expressed the robust faith of the gas profession in the industry, and the intention to maintain and extend its usefulness.

**A Mournful Interlude.**

The prepared agenda was interrupted. There appeared to be a sort of premonition as to what was coming; for as soon as the President was on his feet, no sound came from the large audience. Sensible of the gravity of his duty, he spoke of the losses sustained by the Institution, profession, and industry by the death of Mr. Thomas Newbigging and Mr. John Chew. There were many feeling sentences in the well-chosen language employed. There was recognition of talent, and of faithfulness; and the members recorded in expressive silence their sympathy with the relatives of both those whose presence and voices are lost to them for ever, but whose example, works, and words live.

**Miscellaneous.**

The formality of taking as read the minutes of the last annual meeting was gone through; and then Dr. Elliott was called upon by the President to convey to the members a message from their colleagues in America. It took the form of a sincere wish that many members of the Institution would be able to join in the Panama Pacific Congress of Gas Engineers; and it seems, from the information he gave, that excellent arrangements are being made for the occasion. Then came the appointment of Scrutineers—Mr. John Terrace, of Grimsby, and Mr. G. S. Frith, of Runcorn. A cable was also dispatched to the Société Technique wishing them a successful meeting.

**From Across the Seas.**

Mentioning the presence of Dr. Elliott reminds that special reference ought to be made to the visit of Mr. B. K. Schieldrop, from Bergen, in order to read a paper. We also had the pleasure of personally speaking to Mr. O. Pihl, of Christiania, and Mr. Edelberg, the Engineer of the Valby works of the Copenhagen Corporation.

**Birmingham to the Fore.**

Birmingham did well last year in the shape of contributions to the annual meeting; and it was expected that the representatives of the Birmingham Corporation Gas Department would carry off the medals awarded each for good work. They did handsomely; and the President—always mindful of the proprieties—did not forget to congratulate the Birmingham Gas Committee on the character of the research carried on at their works, and upon the personal qualities of those who undertake the work. To Dr. W. B. Davidson went the London Gold Medal (provided by Mr. H. E. Jones) and the Council also awarded the Doctor the Institution Silver Medal, for his paper on "Liquid Purification;" while Mr. W. Chaney received the Institution Gold Medal for his paper on "Coke-Oven Carbonization." The only medal that this year is not finding a home at Birmingham is the bronze one awarded to Mr. F. W. Goodenough for his paper on "Creating an Outdoor Staff." The great encouragement that the Birmingham Gas Committee give to their technical staff to carry on gas research was acknowledged by Dr. Davidson; and Mr. Chaney, who reckons it was more by good fortune than by merit that he obtained a medal, made a half-promise to lay before the members on some future occasion additional information on coke-oven practice for gas-works purposes—a subject which he believes is still in its infancy. There was also acknowledgment from Mr. Goodenough, whose work in the commercial and distribution department the President spoke of with genial sincerity, and his words the members no less appreciatively endorsed.

**The President's Address.**

The central feature of the first morning's meeting is always the Presidential Address. It was so on this occasion. Into the address the President put a good deal of his own individuality. It is, in fact, one of those addresses that receive an expression which words cannot always convey when the author's voice gives tone to what is written. We will not traverse the address here, in view of what is written upon it in earlier columns. But it should be said that the words of the President were heartily applauded which acknowledged the good part that the late Mr. Alfred King and Mr. William King (who as already mentioned was present at the meeting) took in their combined long years of service in promoting the interests of the gas industry generally, and more particularly in Liverpool, and so added to the history of gas affairs. One of the side points made by the President was that the Garston works of his Company are unique in that only carburetted water gas is made at them. The references to the development of the gas supply in Liverpool were obviously interesting to the members, as was also the information regarding novelties at the works—the "Dryco" system, Professor Thomas's electric-meter, and the mechanical grate fitted to one of the carburetted water-gas generators. Other points of engineering interest were the changes made in the Fiddes-Aldridge machine in order to enable it to deal with larger charges, and the brief allusion to the big Glover-West installation of vertical retorts at Linacre, upon which the contractors have been hard at work in order to get it well advanced in time for inspection at the meeting. There was an incidental reference in the address to the lecture that Mr. Carpenter was to give next morning on heat purification of gas; and the words that the subject would be presented by him "with that thoroughness which distinguishes all his contributions" brought marked endorsement from all parts of the hall. With the observations of the President on the relations between employers and employees, on co-partnership, and on training, there were sympathy and approval. It was an extremely thoughtful action that led Mr. Wade Deacon to propose a vote of thanks to the President. He emphasized the point as to the satisfactory relations existing between the Gas Company and their employees. Speaking of the visit to be paid to the gas-works in the afternoon, he raised a laugh, in referring to the President's mention of the proximity of the Company's centenary, by expressing the hope that, as old as well as new plant would be seen at the works, the members would remember the Company's age, and be kind to their infirmi-

ties. The seconder was Mr. John Young, who had largely in mind the splendid traditions of the Company, and the way they are upheld by the President. For the hearty concurrence expressed by the members, an expression of gratitude came from the President.

### A Fund for a Home for the Institution.

One of the peculiarities of the proceedings at the opening sitting at the annual meeting is, no matter at what point in the proceedings the President's Address is located, the custom for a considerable number of the members to leave the hall immediately the vote of thanks is passed to the President. It was so on this occasion; and those members who left the meeting did not hear the interesting announcement by the President, when the annual report was presented, regarding the matter of commencing a fund—to which anyone may subscribe, and through which the Institution will be able to "save up" money—for the specific purpose of some day establishing for itself a home, instead of being a permanent dependant on others. The matter of a "home" was raised by Mr. E. A. Harman at the Jubilee meeting; and the Council, in conformity with the instruction of the members, have since seriously considered the question. While not unsympathetic with the idea, the Council have decided that it is impossible to take any immediate active steps in this direction; the money element being at present a debarring one. The provision of funds will have to be made gradually; but in order to supply a nucleus for a building fund, the Council have allocated £500 from the funds of the Institution. There was general agreement, judging from the applause with which the members received the step that the Council have taken; and this approval was voiced by Mr. Harman and Mr. George Helps.

Concerning the report generally, the President made incidental reference to the recent suggestion in the "JOURNAL" that the reports of the Council do not disclose much initiative on their part; but, according to the President, the Council take to themselves credit for having started a good many things, which the President did not specify. The reports, he also remarked, do not by any means represent the amount of work that the Council do in the course of the year. One point made by Mr. George Helps was as to the allocation of the awards for papers. He is of opinion that, as there are not enough medals "to go all round," two should not be awarded to one man. He also suggested that the papers read before the Junior Gas Associations should be taken into account in making awards. As to the criticism, the President reminded Mr. Helps that the London Gold Medal had been given for a specific object by Mr. H. E. Jones, and had nothing whatever to do with the Institution's own awards. As to the standardization of pipe-threads, Mr. Helps cannot see any good in bothering about them; as with welding in the field pipe-threads will soon be things of the past. Whereat there was laughter.

### The "Corbet Woodall Scholarship."

There was another gratifying announcement from the President, and that was the desire of Sir Corbet Woodall to provide a sum of money for the foundation of a travelling studentship in the Technical University Departments in our own country, or a scholarship at one of the Continental universities, of £50 a year, to be awarded annually to a student of the Institution, if in the opinion of the adjudicators there is one who merits it. A message was sent from the meeting sincerely thanking Sir Corbet for his generous proposal, and suggesting for his consideration the title of "The Corbet Woodall Scholarship."

### Refractory Materials Committee and Silica Retorts.

We had now reached the reports; and the first one was that of the Refractory Materials Committee, which was presented by Mr. F. J. Bywater, in the absence of the Chairman (Dr. Harold G. Colman) in America. The Committee have been making inquiries into the subject of the use of silica retorts in the United States; and through the kind offices of Mr. Herman Russell, of the Rochester Railway and Light Company, opinions and experiences have been collected. The Committee are going to exchange reports and information with the Refractory Materials Committee of the American Gas Institute. From the report, it is gathered that the material of which silica retorts are made contains about 95 per cent. of silica; and it appears to be identical with the ganister quartz found extensively at home. With regard to the inquiries made in America, it is, in the first place, learned that short lengths (18 inches long) of moulded retorts are now being tried for vertical retort-settings; but experience so far relates to tile-built retorts, or to a combination of bricks and tiles. When the retorts are heated up, expansion takes place from $\frac{3}{8}$ to $\frac{3}{16}$ inch per lineal foot and in the periphery. Methods of overcoming the trouble that might otherwise occur from expansion are described. Experience shows that well-made silica retorts do not crack when first lighted up, or by reason of cold air rushing in when the lids are opened; this being probably due to the segmental tile construction, and the use of solid-moulded fire-clay mouthpieces. Most types of stoking machinery appear to have been used with these retorts without difficulty. The life of the retorts operated by stoking machinery is said to be about three-and-a-half to four years, which is a longer life than clay retorts enjoy as made in the United States. It is believed that the silica retorts have greater heat conductivity than clay ones, which results (it is said) in a lower fuel account, and an increased carbonizing capacity, owing to the charge being burnt off more quickly. In any experimental work on this side with silica retorts, the Committee advise small initial installations and care. A few guiding suggestions are included in the report.

### Influence of Load on Refractoriness.

Under the supervision of Dr. J. W. Mellor, and in collaboration with the Retort and Fire-Brick Section of the Society of British Gas Industries, an investigation has been conducted into the question of the effect of pressure or load on the fusibility of refractory materials. The tabulated tests show that, under various pressures, the melting-point of refractory materials is considerably lowered from the normal. Commenting on the figures, the Committee remark that the decreases shown, of 12 or 13 per cent. when the test sample is subjected to a load of 54 lbs. per square inch while it is being heated, are "very surprising." But it is impossible to say, without further investigation, whether the results will be borne out in practice, though it is thought improbable that the melting-point of fire-bricks is lowered to such a considerable extent in retort-settings. Therefore the figures must only be taken as the result of a preliminary exploration of the subject.

### Working of the Standard Specifications.

The Committee are now endeavouring to arrange for collaboration and exchange of information and tests with the National Physical Laboratory and Professor Cobb's Laboratories at the Leeds University. As to the working of the standard specifications, there have been no complaints in regard to sections Nos. 2 and 3, but sometimes dissatisfaction is heard with regard to retorts made to conform to section No. 1. The disturbing causes appear to be surface cracks, looseness in texture, and cavities and fissures more or less extensive. The Committee remark: "Such defects are serious ones, and ought to be remedied at once." Porosity should not be obtained by cavities of the nature described; and while density must be avoided, retorts should possess sufficient homogeneity to give good surfaces and physical strength. For reasons given in the report, the Committee also urge the importance of attention being given to the destructive influence on retort-settings of dust mechanically carried over with the producer gases.

### Experiences at Sheffield, and Materials and Brains.

In his asides, Mr. Bywater mentioned that Mr. J. W. Morrison had been using silica material at the Sheffield Gas Company's works; and he also referred to the point, as being a singular one, that a large quantity of fire-clay material is sent from this country to the Continent, is there made up, and some of it comes back to this country as manufactured goods. The incidental reference to Sheffield, and an invitation by the President, brought Mr. Morrison to his feet; and it was learned from him that he has used large quantities of fire-clay material containing 85 per cent. of silica. Retorts made of the material have been taken out after being in use 3000 to 4000 days, with the material in the upper part practically as good as when first put in. He has tried material containing 95 per cent. of silica; and though the material stands fair wear, it is too soft. He seemed surprised at the extent of expansion quoted in the report. The suggestion was made by Mr. W. Chaney that

gas engineers should aim at getting a material which, as well as being of a highly refractory nature, will stand salt, of which there are varying amounts in coal. In America, he mentioned, they have been able to find material which is not only highly refractory, but sufficiently stable to withstand the effects of salt. It is a lime-bound brick, instead of clay-bound as is usual; and with ovens made of it 10 tons of coal are capable of being carbonized in sixteen hours. It is thought by Mr. John West that large quantities of material going from this country to be made up abroad show that what is wanted here is brains as well as material. There were remarks by Mr. H. Kendrick; and then a few closing observations by Mr. Bywater. As to the salt question, he states that he has seen retorts made from Derbyshire clay fused on the inside. As one evidence of the value of the Committee's work, he quoted a letter from Mr. Harold W. Woodall, in which it was stated that he finds himself able to obtain infinitely better material than he was able to do before the Committee commenced their operations. Having tested some 2500 samples of material in connection with the system of carbonization with which he is connected, he finds that, whereas in 1911 to 1912 the average shrinkage was 1·5 per cent., he is now able to obtain material with a shrinkage of only 0·25 per cent.

**Ventilation Research.**

In the absence of Professor Arthur Smithells, Mr. John Bond moved the adoption of the report of the Ventilation Committee. Judging from it, there is confidence in believing that the Committee, which jointly represents the Institution and the University of Leeds, will do exceedingly useful work. There is no question that Professor Cobb and Mr. William Harrison, M.Sc., the Committee's Research Chemist (who outlined the contents of the report), will do their utmost to make it so. The difficulties of carrying out an investigation of the kind have for long been recognized as being well-nigh insuperable—at any rate so that the effects can be regarded as having general application. Rooms are dissimilar, and the movements of air currents in rooms are not alike. Therefore investigators are either reduced to the use of an ordinary room, describing its various characteristics as a guide to the conditions under which their work is carried out, or to the construction of a practically air-tight room, the currents of air in which can, at inlet and outlet, be controlled and measured. The Committee have chosen the latter course; and some useful lessons, it is hoped, will be derived therefrom. Quite at the opening of their report, however, the Committee speak of the extreme mobility of air, and its susceptibility to slight changes of temperature and pressure. In an air-tight experimental structure such as they have perforce adopted, the air is largely deprived of its mobility by being restricted, and under curb, in so many ways compared with an ordinary room, and by only being allowed entrance and exit through a bottom fixed opening and an upper fixed one respectively. In an ordinary room (say) in which gas is employed for lighting, and there is a gas-fire in use, the air currents take more than one defined course; and therefore the lessons from standard conditions such as those set out in the report cannot be regarded as being in any respect normal. The Committee recognize this when they say: "It was felt that, in order to secure results which might be of permanent value, although perhaps not immediately applicable without modification to actual practice, it would be necessary to carry out a series of experiments under standard conditions." The room adopted has been made of non-conducting material, as nearly air-tight as possible, and enclosed in another room—the outer room being divided into two equal parts to act as separate reservoirs for inlet and outlet air, so that the fresh air is not contaminated with the outflowing air. Such a room is well protected from outside disturbing influences. No particulars are given in the report as to the dimensions of the room; and if it is as small as the described conditions would lead one to suppose, then that is another removal from the conditions of an ordinary room. The room has been under construction; so that no actual work has yet been carried out in it—work to gain some definite information on ventilation in spaces as nearly as possible free from accidental and capricious influences of what may be described as external factors.

**Gas-Fire Tests and Test Methods.**

Time, however, has not been wasted. Preliminaries have had to be considered, and the lines of, and apparatus needed for, the work have had to be determined and devised. Among this introductory work, experiments have been made to ascertain what, if any, escape of products of combustion takes place from under the canopies of gas-fires—an old type one, and four of more modern construction, with and without flue-pipes. Without a flue-pipe, there were small, but determinable, escapes of products of combustion from under the canopy; but the application of 18 inches of flue-pipe practically eliminated all escape. "The usefulness of a short length of flue-pipe was thus indicated." The report does not tell us whether these were samples of the most modern fires by different makers. Recent tests elsewhere have shown that fires can be, and are, constructed that do not allow products of combustion to escape under the canopy without the aid of a flue-pipe. What is wanted, and what most makers of gas-fires are striving for, is to produce gas-fires that, without affecting their radiant efficiency, are altogether independent of flue-pipes, and so of variable lengths of flue-pipes and the indifference of fitters to those variable lengths. It is, all things considered, a better condition of affairs when the dispensability of a short length of flue-pipe is indicated.

The report goes on to describe the method adopted for the determination of carbon dioxide, which method has been worked out successfully for flue-gas determinations, but as yet not successfully adapted to determinations of carbon dioxide in the air. The method consists of, briefly, the passing of the gas continuously through barium hydrate solution, and estimating the barium hydrate electrically, since the necessary measurements of electrical resistance could easily be made at frequent intervals; the decrease in conductivity representing the barium carbonate formed, and therefore the carbon dioxide absorbed. Investigation has also been made into the methods of measuring low pressures and low velocities of air. An apparatus has also been devised for making measurements and comparisons of the air-drawing powers of burners. If the Committee have not yet got far into solid work, the preliminaries show that the investigators are going to pursue the inquiry entrusted to them in a manner to secure accuracy under conditions which can be fully and faithfully expressed. The progress of the work will be watched with much interest.

**Hints from Various Quarters.**

Speaking of ventilation in the course of the short discussion on the report, Mr. Bond mentioned the great improvement that has been effected in churches and other large buildings in Southport by the substitution of gas for electricity. Professor Cobb wishes it to be particularly remembered that the report is quite of a preliminary character; and in this preliminary work, the Committee highly appreciate the ability and the ingenuity displayed by Mr. Harrison. We heard from Mr. J. Ferguson Bell of bad atmospheres being due to defective ventilation, and not to the use of gas, and of the important stimulus that gas can give to ventilation if properly used. A point to which we have already called attention in summarizing the report was referred to by Mr. Jacques Abady. The tests are being carried out under standard conditions; but the methods under which gas is used for lighting and heating are not standard ones. He therefore suggests that, side by side with the standard conditions, tests should be made under conditions which are met with in everyday life. With regard to the difficulties with which the Committee have met, a further suggestion made by Mr. Abady is that, if the Committee write to Mr. John Simmance he is sure he will be willing to help them. He also thinks it is time that gas undertakings, instead of acting on the defensive in this matter, should act on the offensive, and attack the question of ventilation from the point of view of the assistance that gas can naturally render in this matter. The influence of whitewash and plaster ceilings and walls on the atmosphere of rooms, as treated upon in the famous Rideal and Hehner investigation, was brought to mind by Mr. F. W. Goodenough. Contributions were also made by Mr. J. H. Brearley, Mr. Samuel Glover and Dr. Elliott.

**Phenomena of Surface Combustion.**

The gas profession has sedulously set itself to the cultivation of a higher scientific record; but it has something in the report that was next presented by Mr. Harold Hartley, M.Sc., the Institution Fellow at Leeds University from 1909 to 1912, that is a veritable flight from the plain, homely science of the industry into realms far above

the heads of the majority of its members. One wants to live in really close intercourse with work that deals with the phenomena of the electrical condition of metal surfaces during the absorption of gases and their catalytic combustion to allow one to appreciate fully the bearings of such work. What is comparatively simple to Professor W. A. Bone, under whose direction Mr. Hartley pursued his investigations, is the opposite to those the greater part of whose life is fully occupied with practical everyday work. However, it is only by getting to the root of causes that effects can be properly understood, and largely by the same process that fresh advances can be achieved. That is the position in connection with surface combustion; and Professor Bone wants to get at any remaining hidden causes and bring them fully to the light of day. The report made by Mr. Hartley relative to the work upon which he was engaged at Leeds helps to this end.

The position at the time the investigation was entered upon is stated in a couple of paragraphs at the opening of the report. It is now well known that surface combustion depends upon a peculiar "activation" of the combustible gas, and probably of the oxygen also, by association with the surface. At relatively low temperatures, the intensity of such action varies with the chemical character and physical condition of the surface; but it rapidly increases with the temperature until at bright incandescence there is little to choose between the catalyzing powers of chemically different surfaces—porosity and refractoriness being now the dominant factors. When Professor Bone was dealing with the subject of gaseous combustion before the British Association in the year 1910, attention was drawn to the importance of a systematic investigation of the electrical condition of heated surfaces during catalytic combustion. Sir J. J. Thompson then made the suggestion that it was not improbable that the emission of charged particles from the surface was a factor of primary importance, and that the action of surfaces might alternately be found to depend on the fact that they formed a support for layers of electrified gas in which chemical changes proceed with high velocity. The report, in the first place, summarizes the present state of science concerning the behaviour of gases under the action of chemical forces, in so far as it bears on combustion phenomena. For the principal experiments in the present inquiry, gold was selected as the most suitable metal because of its marked catalyzing power at moderate temperatures, and of its not forming any definite chemical compound with any of the gases under investigation—hydrogen, carbon monoxide, and oxygen. Generally, the investigation proves that not only is there an intimate connection between the occlusion of a gas by a hot metal and its electrical condition, but also that the occlusion and ionization are antecedent to the combination of a combustible gas and oxygen under the influence of such a surface—thus establishing a link between surface combustion and the ionizing properties of hot surfaces. The report then describes the apparatus employed, gives some details of the experiments, and winds up with a summary of the conclusions. We will not reproduce these here; but for them interested readers must turn to the end of the full text of Mr. Hartley's report, as published in this issue. The investigations are being extended to other surfaces by Professor Bone, in the Department of Chemical Technology at the Imperial College of Science and Technology.

After Mr. Hartley had cleverly summarized the contents of the abstruse report, there were a few remarks by Professor Bone, who explained that the research Mr. Hartley undertook as part of his work as the former holder of the fellowship of the Institution dealt with a matter of fundamental importance. What is being done is to try to get at something which is behind the whole question of the chemical combination and chemical affinity of gases.

Luncheon time was now overdue; and the benches were occupied by a sparse audience when this stage of the proceedings had been reached. There was an adjournment; the half-hour lost at the start of the proceedings pushing over to next day one report—that by Mr. Harold Hollings and Professor Cobb—with which it had been intended to complete the morning's sitting.

**The Benevolent Fund.**

Wednesday again presented a sun-clad morning; and, notwithstanding the pleasures of the previous evening at the reception by the Chairman and Directors of the Gas Company, the members came along in good numbers for the opening of the sitting. The first matter to be considered was the report of the Committee of Management of the Benevolent Fund. The devoted work for the fund of the late Mr. Charles Meiklejohn appropriately gave subject-matter for the opening of the report. During the year assistance has been granted to sixteen cases; but had it not been for the generous jubilee donation of fifty guineas by the late Mr. Newbigging, there would have been a deficit of £5 14s. 8d. in the fund. The annual appeal was made by the President; and it was held by Mr. Bell to be very unsatisfactory that there were only 273 subscribers out of the 900 members of the Institution. The circularization of all the non-subscribing members was suggested by Mr. J. C. Belton. But the effective work of Mr. Meiklejohn for the fund when Secretary of the Midland Association was cited as an example by Mr. Bell and the President; the latter urging the Secretaries of other Associations to go and do likewise.

**Purification by Heat.**

It was a powerful lecture that Mr. Charles Carpenter, D.Sc., the Chairman of the South Metropolitan Gas Company, delivered this morning—powerful not only in the quality of its material, but in the forcible manner in which he urged the case for a still higher purity of gas in the interests of the future of the lighting business of the gas industry, which business can be held if only the industry will aim at the ideal of supplying gas which on combustion gives off nothing more than do the human lungs—carbon dioxide and water vapour. The audience that was there to greet, and to listen to, the lecturer was equal to the best of the first day's sitting. The first part of the lecture evidenced close historical study of the question of applying heat to purification. It is no new thing, this proposal of purification by heat. What has been done at the South Metropolitan works has been to find a practical way of surmounting the obstacles to success that all other investigators have found impeded their progress. There have been many men in several countries working at the subject throughout the past century—from Heard, one of Winsor's assistants, to, in the mid-years of the century, Barlow (the first Editor of the "JOURNAL") and Ellissen, and on to Greville Williams, until we come to the Hall and Papst process as practised at Portland (U.S.A.), and to the process as now installed on the large scale at the South Metropolitan Gas-Works, and to the proposals of M. Guillet, which, it is thought by Mr. Carpenter, may prove helpful in the work that is now going on. The theoretical considerations involved in the process of bringing about by heat the conversion of carbon bisulphide to sulphuretted hydrogen were explained by the lecturer. What catalysis means was dwelt upon, and the long experimental search that was made at the Old Kent Road works by Mr. Evans and his assistants for a proper catalytic agent was reviewed. In passing, Mr. Carpenter paid a tribute to the Portland process in referring to the effect that temperature has in bringing about a high efficiency as expressed in the percentage reduction of the sulphur. At 427° C., the percentage reduction was 20·7; and at 704° C., it was 76. But there are objections in the heat intermittency of the process, and possibly in the effect on illuminating power.

Returning to the question of the catalyst, the many investigations in the laboratory, followed by trial on a small working scale at Bankside, and then back again to the laboratory, with defeat the result of the experience under working conditions, make quite a good story of patience and dogged perseverance. In one case, the reaction was found to be so great that the catalyst was melted and a hole was also melted in the retort. Of all, nickel and platinum were found to be the best catalyzing agents. A diagram shows how well they came out in the matter of duty. The curves rise quickly to their best work, and then the lines maintain a high level. In both cases there is between 60 and 70 per cent. reduction, with a balance in favour of the nickel. It was found that reduced nickel would be most useful, and would not be prohibitive. In the experiments, 450° C. was the temperature at which a reduction of between 60 and 70 per cent. was obtained.

The discovery which has enabled the South Metropolitan workers to make a great success of their plant has been the system of preheating the gas to the reaction temperature before admitting it to the catalyst. With each working plant erected, which has been of larger and larger capacity—from the one put in at the Bankside works, that erected at the Old Kent Road works, on to the 15 million plant at

East Greenwich—there have been seen means of simplification and improvement; the East Greenwich plant representing the latest practice. The gas is preheated to 400° C.; and the total heat is 450° C. About every thirty days, the carbon on the catalysts has to be burned off; and the system of doing this was explained. Regarding the oxide purification which follows, the lecturer showed how, even if a gas is practically free from sulphuretted hydrogen when it enters the plant, it might contain, through the conversion of the carbon bisulphide, 30 to 40 grains as it leaves the plant. In dealing with this, he does not think any difficulty will be experienced in a purifier system of four boxes in rotation and two catch-boxes. In addition, all that is required is to put a series of inlets and outlets on the outside leading to the sulphur plant. Concerning durability, a 1¼ million plant has been in operation two years, during which period 400 million cubic feet of gas have been treated by it. Reverting to the catalysts—the nickel impregnated fire-clay balls—the lecturer pointed out that it is necessary to reduce the nickel, because it is a finely divided oxide itself; and it is reduced by heating the material in a current of hydrogen. Up to the present, there has been no reduction in the efficiency of the catalyst. How long it will go on, time alone can show; but its longevity has been one of the means by which simplification of the plant has been carried out. As these things will last for years, it is unnecessary to have the same conveniences for their renewal as it would be if this had to be done more frequently.

**Efficiency and Cost.**

The penultimate point of the lecture was that of efficiency and cost. In the working of the Old Kent Road 1½ million cubic feet plant, the result of the treatment of 2335 million cubic feet of gas was, with an average of 39·74 grains per 100 cubic feet of sulphur before treatment, an average after treatment of 8·22 grains per 100 cubic feet—a percentage reduction of 79·3. The East Greenwich plant has only been at work since April 2. Treating 483 million cubic feet of gas, containing before treatment 35·07 grains per 100 cubic feet, the result was after treatment 7·82 grains—a percentage reduction of 77·7. The effect of the process on gas of high and low sulphur content is shown by the following figures:

| | Before Treatment. | After Treatment. | Percentage Reduction. |
|---|---|---|---|
| Maximum . | 83·78 grains .. | 10·34 grains .. | 83·8 |
| Minimum . | 19·21 „ .. | 5·34 „ .. | 72·2 |

Important is the question of whether the process has any detrimental effect on the quality of the gas. The evidence is solid in the negative. The effect is all of the beneficial order. Here are the results of tests—the figures referring respectively to before and after treatment: Illuminating power, 14·7 candles, 14·7 candles (no change); calorific value gross, 590 B.Th.U., 594·4 B.Th.U., naphthalene, 5·54, 4·71; hydrocyanic acid, 22·19, 18·75. The total cost of working the sulphur extraction process under the condition described is 0·299d. per 1000 cubic feet, including coke at 15s., clinkering furnaces and aërating the catalytic material, power, supervision and testing, repair and maintenance, and depreciation and interest (10 per cent. on capital cost).

Regarding Mr. Paterson's coal-liming process, Mr. Carpenter does not think it goes far enough. He also referred to some tests made at Sunderland, through the kindness of Mr. Dru Drury, with the heat purification process on Dessau produced gas. In Mr. James Paterson's Southern Association paper, he gave a figure of 20·48 grains per 100 cubic feet; but it was found, as the result of average tests, that the gas from the Dessau retorts at Sunderland only showed 22·31 grains—about half what one would expect with horizontal retorts. With a small heat purification plant, this was brought down to 5·93 grains. The lecturer also spoke of the work of M. Guillet, which he believes will be very helpful in attaining further progress.

**A Plea and Distribution of Credit.**

When, towards the end of the lecture, Mr. Carpenter said he feared he must have wearied the members, there was a unanimous cry of "No," which would not tolerate contradiction. Almost the final words were a plea for the ideal quality of gas to be aimed at. Mr. Thomas Hawksley, the first President of the Institution, showed in a small bottle, when addressing members in those early days, the quantity of sulphur contained in 1000 cubic feet of gas, and urged its removal. The Rev. W. R. Bowditch many years ago also urged the matter from the commercial standpoint; and he did not think the consumer of a certain quantity of gas would object to paying 2s. 1d. more a year, in order to get rid of the quantity of sulphur represented by the contents of a large bottle that Mr. Carpenter held up, or the consumer of double the quantity 4s. 2d. to get rid of the quantity of sulphur shown in another large bottle that Mr. Carpenter exhibited. The quantitative illustration of these bottles went home. The lecturer thinks there is more in these appeals of days long since than many give credit for. In the heat purification process, success has been attained by the collaboration of the chemist and the engineer. He was sure that Mr. Doig Gibb did not mind him coupling his name with his own in saying this. To the Company's Chief Chemist (Mr. Evans) are due the chemical and physical foundations of the process, while to Mr. C. F. Franks, Engineer at the Company's Bankside station, has been mainly due the constructional work. These two gentlemen, said the lecturer, deserved the lion's share of honour; and he was glad of the opportunity of acknowledging it. Hearty cheers followed this declaration. Then came the final word. If our industry, says Mr. Carpenter, is to prosper as it *can*, and as it *must*, chemistry must guide it, so that, at the end of a second century's service, the industry will be found in a stronger and more impregnable position than (strong as it now is) it is in to-day. As Mr. Carpenter sat down, there was renewed applause, which contained in its heartiness the verdict of success.

**Is it all Necessary?**

An epoch-making lecture was a remark of the President in proposing a vote of thanks to the lecturer; and the highest tribute was also paid by Mr. Thomas Goulden, the Chief Engineer of the Gas Light and Coke Company, who recognizes, as all must do, the indebtedness of the gas industry to Mr. Carpenter. Mr. Goulden was glad to hear, from the historical sketch, that the Gas Light and Coke Company had done much early work on this subject; but he congratulated the South Metropolitan Company's staff on having worked out the problems in the successful way they had done. Respecting the subject of sulphur purification generally, he made the point that it is not the same problem now that it was when flat-flame burners were in use, and when the consumption of gas for rendering a certain amount of light was much larger than it is to-day. He looks upon this extreme purification as a refinement wanted by the few rather than by the many, though, of course, he is not prepared to disregard it if it can be done at a reasonable cost. While being led away by the fascination of the system, he was reminded of the work of Rideal, and Hehner, and Lewes; and he expressed the view that, if sulphur does not exceed 40 grains per 100 cubic feet of gas, there is little prejudice against the use of gas in rooms. The motion was carried, and was emphasized as Mr. Carpenter rose to make acknowledgment. Among his remarks, he urged the members to look at this question from the point of view of those concerned with the sale of gas; as, in his opinion, gas men have hitherto been governed too much by the requirements of the works. The ideal illuminant of the future, he thinks, will be a flame burning in each room—a miniature sun—the products of combustion from which will be only water and carbon dioxide. He besought one and all to work for a still stronger position for gas in the lighting field.

**The New President and Vice-Presidents.**

The Scrutineers' report having been received by the President, he announced, much to the pleasure of the members, that Mr. John Bond, of Southport, had been elected President, that Mr. John Young, of Hull, had succeeded to the Senior Vice-Presidency, and Mr. A. E. Broadberry, of Tottenham, had been elected Junior Vice-President.

**Carbonization Investigations at Leeds.**

The dissolution of the Carbonizing Committee comes appropriately in the year in which the first report is made on the carbonization work which, under the direction and supervision of Professor John W. Cobb (Livesey Professor), Mr. H. Hollings, B.Sc. (Gas Research Fellow) has been carrying out. "Comparisons" are sometimes "odious;" and so we will merely say here that their introductory report shows that there is, and will be, much practical value in the

work that is being conducted at the Leeds University, in this direction. The present report in itself—through the examination made in it of the work of Mahler, Constam, Euchène, Barnum, and others on the thermo-chemistry of carbonization—is of more than ordinary value; and Professor Cobb and Mr. Hollings are, though their investigations are far from complete, to be complimented upon the thoroughness of the work, and the stage it has already arrived at. The authors of the report (the contents of which were outlined by Mr. Hollings) draw attention to the fact that a number of chemical studies have been made of the distillation of coal—such as those of Burgess and Wheeler and Vignon, in France. But the present investigation has been directed to the thermal phenomena during carbonization—the temperature changes occurring during distillation, which are different from the changes that would occur during the heating of an inert substance such as coke or fire-clay through the same temperature range. There is no question that the correlation of the results obtained with those realized by purely chemical means might be useful. Regarding the work that has been done on the relationship between the calorific values of coal and its distillation products, it appears that the distillation is exothermic when the calorific values are determined at ordinary temperatures. But the authors still consider that the question is open so far as concerns the heat evolved or absorbed during the actual process of distillation at the temperatures used. They have therefore attempted to see how far it is possible to divide the process into thermal stages—heat absorbing, heat evolving, and thermally neutral.

The method employed consists in heating, side by side, and under the same conditions, a coal which underwent distillation, and a coke which could be regarded as chemically and thermally inert, and noting, by means of the Roberts-Austen differential arrangement of thermo-couples, the extent to which the temperature of the coal became higher or lower than that of the coke at various stages of the distillation. Complications arising from the secondary decomposition of distillation products were minimized by using a small quantity of coal and sweeping away the products by a stream of inactive nitrogen. The apparatus employed is fully described in the report. By the method, bituminous coals, anthracites, cannel coal, cellulose, and dehydrated cellulose have been examined. While the authors do not consider that the heating curves obtained afford any quantitative data as to the net thermal result of carbonization, it would seem that, in the case of all the typical coals examined, the net quantity of heat involved is very small, since there are both exothermic and endothermic reactions taking place. It is not improbable that at certain temperatures both exothermic and endothermic reactions take place simultaneously; thus considerably increasing the difficulty of detecting changes. In no case was any evidence found of a sudden decomposition at any definite temperature, such as the exothermic decomposition of pure cellulose. The decomposition of coal appears to consist of a very complicated sequence of reactions extending over a wide temperature range. The distillation, as revealed by thermal changes, commences at 250° C.; and, between this temperature and 1100° C., a number of fairly well-defined stages have been detected during which exothermic or endothermic reactions predominate. The difficulties encountered in the research have been considerable, principally owing to the lack of chemical data respecting the products evolved from coal at different temperatures. As more data concerning the sequence of the chemical changes taking place during carbonization become available, a much more complete explanation of the results of the research will be possible.

We cannot indicate in a few lines the results presented in the report of the examinations and comparisons made of prior work in the light of the present investigation. The report is one for study, and not for superficial survey. The points so far referred to form the first section of the report. There is a second section which treats of the

### Influence of Red-Hot Coke and Radiant Heat on Volatile Products.

Here an attempt is being made by Professor Cobb and Mr. Hollings to isolate cause and effect in relation to the breaking-down of volatile products as a result of contact with the surface of hot coke, or of the action of the heat radiated from the walls of the retort, or both. The report brings us into view once more with the subject-matter of Professor Cobb's lecture to the North of England Association on the first Saturday in May. The apparatus employed in this part of the research is described; and the details of the experiments are recorded. Coal distillations were, in the first place, carried out under various conditions, so that satisfactory preliminary evidence might be obtained as to the influence of red-hot coke and radiant heat on the whole of the gaseous products of distillation. Here the difficulty of carrying out instructive tests is encountered, seeing that surface action cannot be entirely eliminated, owing to the necessity for some containing vessel; and the irregularity of the coke particles makes it impossible to find precisely the area of heated surface to which gas is exposed. If surface action could be eliminated, diametrically opposite conditions to the normal would be obtained. The result of subjecting the immediate products of distillation to the action of radiant heat in an unpacked tube was an increased yield of gas equivalent to 1100 cubic feet per ton; the comparison being made with experiments in which the products were removed as quickly as possible from the hot part of the tube. It was quite evident from the results that, by passing the products through a column of hot coke, some further increase in the volume of gas was obtained—equivalent to 1250 cubic feet per ton. These increased volumes were realized without heating the coal or coke above 800° C. The gas analyses indicate that the influence of the heat was felt most by the unsaturated hydrocarbons, and that there was a marked increase in the volume of hydrogen. This extra hydrogen was not secured at the expense of the methane, but was most probably a product of the decomposition of the higher hydrocarbon vapours and tarry matters generally. The decomposition of methane under gas-retort conditions is only appreciable when temperatures higher than 800° C. are reached.

### Ammonia Yields.

Under the several conditions of the experiments, the authors made determinations as to the yields of ammonia; but they do not present the results as conclusive on the point of the decomposition of ammonia, but only as indicative until further and more complete experiments are carried out. In the first experiment (No. 6) 2 grammes of coal were taken, and the volatile products were passed *through the hot coke bed;* 10·1 per cent. of the nitrogen in the coal being recovered as ammonia. Repeating the experiment (No. 6A), 8·7 per cent. was obtained. In experiment No. 7 the volatile products from 3½ grammes of coal were passed *through a hot empty tube;* and 18·2 per cent. of the nitrogen was recovered as ammonia. A further experiment (No. 7A) gave 16·2 per cent. with a temperature of 800°. Three experiments (Nos. 8, 8A, and 8B) were made, using 3 grammes of coal in each distillation; and 22·1 per cent., 25·1 per cent., and 20·2 per cent. of the total nitrogen was recovered as ammonia. The mean of each set of experiments is as follows:

| | | | |
|---|---|---|---|
| 8, 8A, & 8 B (minimum heat action) | . . | 22·5 p.c. of $N_2$ as $NH_3$ | |
| 7 & 7A (radiant heat) | . . . . . | 17·2 | „ „ „ |
| 6 & 6A (hot coke surface) | . . . . . | 9·4 | „ „ „ |

The results confirm the findings of modern carbonizing practice. The agreement between the experiments of the same group cannot be described as good; but the very slight differences in the rate at which the coal was raised in temperature may account for this. More concordant results will no doubt be obtained in future when more time can be devoted to this aspect of the investigation.

The report includes other indications as to the scope of the work carried out. There are references to the absorption of hydrocyanic acid, notice of experiments on flowing gas with a description of apparatus, allusion to the synthesizing of coal gas, and information on the decomposition of methane, ethane, ethylene, and benzene.

There was acknowledgment from Dr. Lessing as to the value of the work done. Though it has only indirect reference to gas-works' processes, it would be, he said, useful for guidance to those engaged on work on the practical scale. There were also a few appreciatory remarks from Mr. Robert Watson. Professor Cobb mentioned that what was contained in the report is only the beginning of a piece of work which would have to form subject-matter for the research chemist for years to come.

### Coke Makes a Happy Land—and Gas Managers.

Mr. B. Schieldrop is right. If we could only plant the domestic heating custom of Norway in this land, gas-works

would be exceedingly happy in their coke market. Mr. Schieldrop came from Bergen to tell his British colleagues something of his experiences and practices; and he compressed them all into comparatively few words and a couple of diagrams. He opened his paper (the reading of it finished the proceedings on Wednesday morning) with an attempt to make his British *confrères* envious. We do not think he really succeeded, but he certainly made "their mouths water." A difference between Norwegians and our people at home is that the former like closed-in stoves, the latter the open fire. The preference here will continue; but British gas managers would have no objection to many other countries having a preference that would create a good demand for this country's gas coke. For his coke for domestic purposes—coke from Durham coal—the author gets 28s. per ton for the screened unbroken variety, and 30s. for broken coke. There, as he puts it, gas-works in Norway have "an excellent economic foundation for gas-making to rest upon." The use of these stoves, with their adjustable draught, is the reason for the clear atmosphere of the towns of Norway, the absence of a Smoke Abatement Society, and of any need for a Departmental Committee to inquire into the smoke nuisance. At present, the gas-works of the country can only supply 30 to 40 per cent. of the national demand for coke; and the remainder is imported principally from the Tyne district. There is no objection to this state of things continuing. There was a touch of humour about the point made in the paper as to the imported coke not being so profitable as the home product, though the consumers probably do not see things in quite the same light. Coke is sold by measure; and the rougher the surfaces of the coke, the less quantity goes into a measure. The home-made coke not having passed the ordeal of a journey from the Tyne district is therefore more profitable to sell, seeing that the imported coke has had its rough projections worn off by much handling and friction, and so goes more compactly into the measure. The Norwegian gas managers also keep their coke light and dry. They find, too, there is not so much care exercised in using a minimum of water for quenching coke in Great Britain. They buy by weight, and sell by measure; and the conditions with imported coke are against them. Another result of this demand for coke is the use of breeze in many places, with step-grates, for heating horizontal retorts.

### Graphic Presentment of Results.

The paper includes a graphic representation of the economic results of operations at the Corporation gas-works at Bergen; this form of graphic representation being based on a system agreed upon by the Norwegian Society of Gas Engineers. It shows costs per 1000 cubic feet under various heads. For ready comparison, and presentment to the eye of differences, the idea is a good one. But for general publication purposes, diagrams of this kind would offer the difficulties of excessive cost and an enormous demand for space. For publication the statistical and analytical method will still have to be adhered to. However, the author submits the question for consideration whether a graphic system of the kind, with perhaps some modifications, might not be adopted outside Norway. In 1912-13, the net cost of gas in Bergen was 0·83d. per 1000 cubic feet. This brings us very close to the ambitions of Mr. Isaac Carr and Mr. J. G. Newbigging. For the explanation of this Bergen experience, the paper must be consulted.

### Competition of Electricity.

But Norway gas has to compete with electricity generated by water power; and consumers can run electric-lamps there as long as they please for a comparatively small sum per year—for example, 8s. 3d. for a 50-candle power lamp, a price which would permit a 50-candle power inverted gas-lamp being run for 1333 hours, with gas at 2s. 6d. per 1000 cubic feet, which looks as if values in Norway are about level. However, notwithstanding the shrinkage of the use of gas for lighting purposes through cheap electricity, the consumption of gas for cooking and heating has more than compensated for the loss. The consumption of gas has never been so great as since electrical competition set in. The increase for the whole of Norway last year was no less than 15 per cent.; and in Bergen alone in the last three years, the annual increase has been between 25 and 33 per cent. No wonder that fresh extensions of works are required. It is interesting too to see that the extensions are being made on the vertical retort system—the Glover-West being the plant adopted at Bergen. The author of the paper is heartily congratulated upon the amount of interest that he succeeded in compressing into its modest length.

### Gas-Fitters' Examinations.

In the afternoon there was a meeting at which the oft-considered subject of the training and examination of gas-fitters was discussed. The position at which the question has arrived is well known; and those present took into consideration the point as to how best to utilize the new order of things which has been brought about by the conferences and negotiations of the past. Nothing very definite appears to have been done yet; and it seems that some inventive genius is required to formulate the proper lines to pursue. One suggestion that received almost universal favour was that, especially in the South of England, where districts are scattered, there should be travelling teachers, who could go from place to place.

### Back to Norway.

The paper that Mr. Schieldrop read the previous morning was the first topic for discussion at Thursday's sitting. There was a falling-off of attendance compared with the two preceding days; but we have seen worse audiences on last-day sittings. It was an appreciative audience; and Mr. Schieldrop was pleased at the interest taken in his paper. The coke question was the main one; and the author of the paper found himself revelling in quite a mass of congratulation in regard thereto from Mr. J. Ferguson Bell, Mr. John West, Mr. John Carter, and Mr. George Helps. We all appreciate that there is much waste of valuable constituents going on in connection with our crude system of burning coal for house warming. As Mr. Bell says, only some 10 or 12 per cent. of the heat of crude coal is used in warming a room. The Continent, he thinks, manages these matters better than we do here; but, of course, there are things to be said on both sides—here we prefer radiant heat and our rooms not stuffy. "Enough to make every one of us green with envy" was one of Mr. Carter's terse and apt remarks in looking at the favour of coke in Norway. If the gas managers of this country could only reproduce the conditions of Bergen, they would be able to look on the financial result of this year with equanimity. The British Commercial Gas Association and the London Coke Sales Committee will note Mr. Carter's view that, despite their work for coke, gas-works do not appear to get any nearer a more comfortable position in connection with it. What he thinks is wanted is someone strong enough to do something really good. But, after all, the main point is to wean the Britisher away from his love for a coal fire. The suggestion was made by Mr. George Helps that Mr. Schieldrop should consider the question of gasifying his coke, and transmitting the fuel through pipes in the gaseous form. What struck Mr. J. C. Belton chiefly was that although electricity is so cheap in Norway, it cannot combat gas and coke for cooking and heating purposes. There were a few remarks by the President chiefly pointing to the internationality of the gas industry.

### Electricity and Cooking and Heating.

Mr. Schieldrop, in his reply, revealed himself a humorist as well as a good gas engineer and manager. He described as a "model and desirable aim" the gasifying of gas coke, and the supplying of the fuel in that form; but requirements and customs as in this country have a prevailing influence. The work of electricians in Norway in competing with gas for the cooking and heating loads is just as uphill as it is in England, because the units of heat for a given price fall so much below those got from gas. He took the gilt off the cheap water-power generated electricity schemes, when he made the two points that the transmission of the energy is expensive, and that the owners of waterfalls soon figure-out the real commercial value of the natural sources of power. Indeed, the owners would be silly men if they gave the power away for anything less than was necessary. Electricity cannot be sold for nothing. Schemes were occasionally brought forward in Norway as in this country by which several hundred per cent. duty is claimed to be

obtainable from electricity; but the duty does not work out in practice. [Laughter.]

**Calorific Power as a Standard.**

Among current subjects this is one that should have prominence in consideration where gas engineers and managers are in conference. There was, at the call of the President, a settling down with good expectation to the paper by Mr. Jacques Abady. The communication was a comparatively short one; and, to be frank, we do think Mr. Abady might have made more of it. The author's ability to deal with the subject from all aspects is too well known to need even the mention of it.

The author moved off with the view that the consideration of the utility of calorific power as a standard for parliamentary bargains affords no scope for original thought or expression, which was totally unnecessary self-abasement. But there was the pious hope that the paper would serve "to place on record the past ["past" might have been "deleted] history of the standard calorific power question." Really we had been vain enough to think that everything that was worth knowing in regard to the "history" of the calorific standard question had been placed on record. The progress to the present stage of the nascent establishing of the calorific value standard had its real inception in the war waged some years ago by Sir George Livesey upon legislative trammels and photometric waywardness. There was reference to the result of the parliamentary attacks—the Departmental Committee of 1904, on which Committee Mr. William King, the late Engineer of the Liverpool Gas Company, served, and that Company was this parliamentary session one of the two that helped to set definitely the lines of parliamentary enactment in relation to the calorific standard. The recommendations of the Committee may be said to have been the first effective step in the rapid changes that have taken place since in connection with the standard quality and testing of gas. The recommendations are well known to professional gas engineers—if they are not, they clearly ought to be. Thanks largely to Mr. Charles Carpenter, D.Sc., the Committee also reaffirmed the principle that in testing gas the supplier "is entitled to the maximum result obtainable as a measure of the value of such gas;" and incidentally, let us add, thanks are due to Mr. Abady for what he has done in pressing home the right of gas suppliers to the total heat value of gas, as specified to-day in the Bills pending of the Gas Light and Coke Company and the Liverpool Company.

However, in 1904 we had reached the position where it was recognized that the bulk of the gas distributed in the United Kingdom was used for its calorific power, and only a small portion for its illuminating power; that there was no real utility in the argand burner for testing; and that flat-flame testing might be useful for information purposes only. London subsequently came under the recommendations so far as information testing went for calorific value and luminosity of the gas used in flat-flame burners, with the testing for standard illuminating power incorporating Mr. Carpenter's "Metropolitan" No. 2 burner, which gave to the gas its maximum illuminating value. The double test imposed—not by Parliament, but under an agreement (under protest) with the London County Council, in the case of the Gas Light Company came about in 1909. In 1912, the Wandsworth Company accepted a calorific standard; and a little later in the session, the South Suburban Company also had a calorific test applied—in both these cases the illuminating power test being extinguished excepting in a small part of the South Suburban area, where the calorific standard was not to apply. It ought to have been stated by the author that the South Suburban terms (which were contended for by the Chairman of that Company, Mr. Charles Hunt) have given, in large part, the model for what has since been done—the differences being only in respect of the margin between standard and penalty point, and the restriction of the testings for penal purposes to the mean of two in one day, instead of to the average of the testings over three days. As the author points out, in these cases and in others prior to this session, the local authorities did large part in promoting the adoption of the calorific value standard.

**The Settled Conditions.**

The opening of the present parliamentary session, as readers are aware, saw several promoters voluntarily seeking for a calorific standard; and the Gas Light and Coke Company asking for the abrogation of their illuminating power test, and the revision of their calorific power one. The result has been, through Lord Clinton's Committee, to give formularized expression to the conditions of a statutory calorific standard, though it is well understood now, as has been emphasized in the "JOURNAL" and is further emphasized in the paper, that the actual number of B.Th.U.'s forming the standard will, if Committees do their duty, be considered in each case. The fixing of the standard according to circumstances is the view of the Board of Trade; and Lord Clinton's Committee gave precedent to the view by making a distinction between the Gas Light and Coke and the Liverpool standards. The principal terms are identical, and are, for the Gas Light Company, as follows: Daily test with penalties; standard, 540 B.Th.U. gross [Liverpool: 550]; no penalties unless calorific value is less than the standard by more than 7½ per cent. [Liverpool: 5 per cent.]; apparatus to be employed and tests to be made in such a way as to obtain the *total heat value* from the gas; non-penal flat-flame testing, without a prescribed standard. With the author, we are of opinion that the provision as to flat-flame testing for information only will have an early death; for few local authorities are likely to trouble themselves about it for any length of time. Inutility will kill it.

**Some Suggestions.**

In the case of the Liverpool Gas Company, a minimum pressure of 12-10ths was imposed. The author suggests that, seeing that a higher pressure gives more value to a foot of gas, and means (he says) increased unaccounted-for gas, when the minimum pressure is raised there should be a corresponding increase in the standard price. It is to be feared that current pressure practices would make any such proposition, if seriously laid before a Committee, look rather absurd. In his concluding passages, the author urges, as has been impressed before on those responsible for the technical work of gas undertakings, that a thorough study should be made of the calorific power question in all its bearings, so that the ideal standard figure for each undertaking could be submitted to Parliamentary Committees. It is also suggested in the paper that the Institution should take into consideration the possibilities from every point of view of the supply of cheap power gas alongside the normal supply of gas of standard calorific power. If the Institution does this, it is likely that it will also take into consideration the capital expense, and the more rational idea as to whether there is not better work to be done in carbonizing and working so that the greatest possible number of B.Th.U.'s can be sold for a penny for any purpose. The provision of a dual supply might be an obstacle to greater all-round economy flowing to the consumers through one set of mains.

**The Question of Uniformity of Standard.**

Opposing any general treatment of the subjects raised in the discussion is the individuality that there is about most of the remarks made on the paper—the contributors being the President, Mr. George Helps, Dr. A. H. Elliott, Mr. Walter Grafton, Mr. John Bond, Mr. E. W. Smith, Mr. J. Ferguson Bell, and Mr. S. B. Langlands. The President sticks to his preference for a uniform quality of gas, in order that anywhere maximum efficiencies may be obtained from appliances by which gas is consumed; but, as Mr. Jacques Abady subsequently pointed out, this means something more than standard calorific power. It means standard constitution of the gas. At the same time, Mr. Allen says it is not desirable that the present Liverpool standard should be followed by other undertakings. The President had received a letter from Mr. Shadbolt who has been in London on the Skegness Gas Bill, in which letter he reported that, in an interview, the Lord Chairman has agreed that the Liverpool standard shall not be taken as a precedent for other Provincial gas undertakings. His Lordship appears inclined to allow 500 B.Th.U.; but he does not seem quite ready to grant the 5 per cent. margin with a standard of 500 B.Th.U., though he concurs there may be cases warranting 5 per cent., or even more. The President agrees that the penal point is too high. It is desirable to supply a maximum of heat units for a penny; and a margin of 5 per cent. is not sufficient for practical working. At the Linacre works, a 7 per cent. margin is required. Mr. Abady's reply showed that he is perfectly prepared to accept one

standard for the whole country, providing there is enough scope in the margin. Mr. Grafton favours a standard not set too high, and no margin—say, 490 B.Th.U. for coal gas, and 455 or 460 B.Th.U. for mixtures of coal and water gas. Mr. Abady is not at all sure that he, theoretically and ideally, is not in agreement with the fixing of the standard low enough to do away with the margin. Mr. Bond favours 500 B.Th.U. with a 5 per cent. margin. Mr. E. W. Smith is of opinion that different districts need different calorific standards. With the variety of elevations in Birmingham, they have to provide a higher calorific value than is done in London, in order to get the same value under the "boiling pots."

### Low or High Grade Gas.

On the point of pressure, Mr. George Helps believes in increasing, and having only one, pressure. There was a lot said about "standards;" but seeing that the consumer dilutes his gas down to 100 B.Th.U. with air when he commences to use it, there is, asserts our Nuneaton friend, no reason in having high standards. But Mr. Helps seems to overlook the point that there must be a fundamental standard. Mr. Abady directed a little shaft at Mr. Helps when he told him that he cannot see why gas makers should dilute the quality of their gas because the consumer has to dilute it according to the purposes for which he requires it. He frankly describes the point raised in this connection as "nonsense." Dr. Elliott on the same point made the remark that he does not believe in sending out diluted gas; he holds in a higher quality or a higher pressure. So Mr. Abady finds there is a great gulf fixed between Mr. Helps and Dr. Elliott; seeing that the latter might like to go up to 5000 B.Th.U. Why Mr. Abady does not want the calorific power to be fixed too high is that it may prove possible some day to supply a lower grade gas, and yet give the consumer more value in B.Th.U. for a given price. However, Mr. Helps is against the idea of sending out two grades of gas. Mr. Smith was also in disagreement with Mr. Helps as to distributing a gas of very low calorific power. It is preferable, he thinks, that the consumer should dilute the gas to suit his requirements.

### Conditions of Calorific Testing.

Mr. E. W. Smith is also of the view that the Council might appoint a Committee to consider the question of standardizing the conditions for calorific value testing; and Mr. Bell concurs in this. Mr. S. B. Langlands would also like the conditions simplified. Upon which Mr. Abady considers that it is desirable that some work should be done in the formulating of conditions for carrying on calorimetric work; and he sees no great difficulty in this. He will be very pleased to place at the disposal of the Council the results of any experience that he has had, and work that he has done, in this connection. The President handed over the subject of the suggested standardization of calorific testing conditions to his successor to bring before the Council.

### A Message from the French Society.

A message appreciatory of the one sent to the Société Technique earlier in the meeting was received from the President of the French Society, together with all good wishes for an enjoyable meeting.

### Coke-Ovens and Direct Recovery.

This first experience of accepting a paper from a member of a Junior Association will, we hope, encourage the Council to accept others in future. It will be a surprise if the Council do not, at the next annual meeting, mark their appreciation of the technical material Mr. G. Thomson Purves, of the Scottish Juniors (Western Section), placed before the meeting on this occasion. It was really the only paper that treated of carbonization; and moreover it introduced for discussion the question of direct ammonia recovery, which is one to which gas technicians will, under changing conditions, have to devote more attention than hitherto. A challenge is thrown down at the beginning of the paper when the author says that "heavier charges have played a part in gas-making progress, and coke-oven carbonizing is the ultimate end of such practice." Of course, the author might at once have qualified this by mentioning the fact that coke-oven practices have limitations so far as gas-works are concerned. There is scope for them, but with boundaries to it. It is agreed that the common aim of gas manufacturers is an increased financial return per ton of coal carbonized, and per £1 of invested capital; but the financial information in the paper is somewhat scanty. There is, however, in it plenty of interesting material which enables an examination to be made of the results of coke-oven practice, with "Otto" direct recovery. But it would have been of advantage if the author had entered into the controversial side of the direct recovery system by discussing the relative merits and demerits of high-temperature and low-temperature direct recovery.

### Question of Coke Quality.

After his opening, the author discusses the question of the quality of coke. Of course, the primary object of coke-ovens is the production of a hard, homogeneous coke. The size and hardness of the coke are, in the first place, dependent on the coking qualities of the coal; but they are also affected by the stamping of the charge, moisture, temperature, and time of carbonizing. Too high a temperature results in hard coke, but smaller in size; low temperature gives blacker and softer coke, but larger pieces. There was a little cut at continuous verticals in dealing with coke quality. Coke-oven experience shows that, when the temperature has just passed the coking period (the low-temperature carbonizing period) the coke is relatively soft, and is easily broken up. "For this reason the author does not view with favour the movement of the coke in continuous working." Large coke, however, is obtained in continuous vertical-retort working, even if it is not of such dense texture as coke obtained from intermittent working; and the moisture content is low. It is an excellent yield of coke—78·5 per cent.—on dry coal that the author realized from his coke-ovens last year, with moisture only amounting from a trace up to 2 per cent. Gas-works would like to procure equivalent results in ordinary working. The actual selling price of the coke for the year to May, 1913, was 7s. 0·4d. per ton more than that of gas-works coke in Glasgow. But the markets are limited for such coke.

### Town Gas from Coke-Ovens.

The next part of the paper described the "Otto" regenerator coke-oven. The temperature efficiency of the system is attested by the fact that the temperature of the hot products of combustion is reduced from approximately 1150° C. down to (say) 250° or 300° C. before passing to the chimney. With normal coking coal, 50 to 60 per cent. of spare coal gas is obtained for purposes other than the heating of the ovens. Having in view the proposals in Parliament this year—the Middlesbrough Corporation and the Thornaby-on-Tees Bills—to purchase gas from Sir B. Samuelson and Co., Limited, it is interesting to learn that a battery of ovens of the "Otto" design is being put down for that firm, from which the gas will be supplied. The price at which the gas is to be sold to Middlesbrough is 4d. per 1000 cubic feet.

### Points as to the Products of Distillation.

In dealing with this matter, it is seen that—contrary to what we were led to expect recently by "Amicus" [*ante*, p. 413]—there is in the "Otto" process partial cooling and condensation of the crude gases in collecting and foul mains before reaching the tar-extractor, into which they must enter at a temperature not lower than the dew-point. The extractor is of the "Otto" spray-tar type. In this apparatus, the chloride of ammonia present in the gas is scrubbed out along with the tar, and dissolves in the liquor. The author prefers the use in the extractor of liquor instead of tar, as is the Continental practice. An important point is made by him when he states that, in the "Otto" method of tar extraction, there is complete separation of the heavy tar from the gas while the temperature is between 158° and 176° Fahr., and with practically no extraction of light oils. In proof, the results of a distillation test are shown in the paper. Another point with which "Amicus" has to contend, as it affects the statements in the article already referred to, is this: The fraction (7·25 per cent.) of the distillate up to 170° C. contained 5·25 per cent. of water; and the remaining 2 per cent. was almost entirely naphthalene. The fact, too, that the tar

does not contain light oils permits of it being kept hot with steam till complete separation from the liquor takes place.

### Direct Ammonia Recovery, and Naphthalene Treatment.

The direct recovery of ammonia is the point on which as much information as possible is desired by gas men. The "Otto" system is described in the paper. There is intimate contact of the gas with the acid in the saturator through the gas being split-up into fine streams through a slotted curtain suspended in the acid liquor, which is kept in continuous circulation. When the state of acidity of the saturator liquor is considered (there being considerably less than 11 per cent. of free sulphuric acid present), it is not to be expected, says the author, that the illuminants benzene and ethylene would be attacked. The analyses given in the paper of samples of the gas taken at intervals at the outlet of the saturator, over a period of five-and-a-half hours, show that the gas is approximately equal in all respects to ordinary town gas, and that it has a calorific value of 560 B.Th.U. net per cubic foot. [Now that the parliamentary standard is in gross value, we shall have to get authors of papers to mend their ways, and state the gross and not the net calorific power.] The gas is next treated in a naphthalene extractor, and then in gas-works is passed through purifiers; or, in connection with coke-oven plants, through the benzol scrubbers. Regarding sulphate of ammonia production, the author has had the excellent average return of over 36 lbs. over a year's working. The process of direct recovery can be considered quite apart from coke-ovens; the important factor being that the gas should reach the tar-extractor at a temperature not lower than the dew-point.

### Costs.

The capital cost of a complete "Otto" coke-oven plant, with direct recovery, for 360 tons of dry coke is given as approximately £60,000; and some figures as to labour costs are also quoted. Towards the end of the paper, Mr. Purves revives the old idea of pithead carbonization, and gas distribution at high pressures, and does so in the cause of economy. The economy would have geographical limitation, when all costs were considered, and the charge for the distribution of the products--especially coke—was taken into account.

### Too Much Metallurgical Coke.

Whatever is done, it seems to be inevitable that papers must suffer ill-treatment at the annual meeting of the Institution. Time was now pressing; and there could only be a few remarks on this interesting communication. Mr. John Young reminded those present of the paper that Mr. Charles Hunt read some years ago on the Brymbo coke-ovens, and his consideration those several years since of the question of bulk carbonization for gas-works. It is clear Mr. Young is only prepared to look with limited favour on the coke-oven for gas-works purposes. He finds the markets for metallurgical coke overstocked; and on the Continent—especially in Belgium, where towns have given up their ordinary coal-gas making methods and are taking gas from coke-ovens—the owners of the ovens do not know what to do with their coke to-day, as it cannot be used for domestic purposes. Mr. J. P. Leather wants to know more about the direct recovery process, and get information as to the possibility of using the system without destroying any part of the properties for which gas is sold. Mr. Purves's reply to this was to the effect that his experiments indicate that both illuminating power and calorific value can be maintained with the direct-recovery system. There was dissent on his part from any suggestion that in the paper he advocated the universal application of coke-ovens for gas making—one of his points being that there are several factors limiting the possibility of application, such as the availability of suitable markets for the products. But direct recovery is something which can have universal application. He believes that both illuminating and calorific values are increased under it, because no light oils are extracted from the gas—at all events, none are found in the tar.

### Improving Crops by Fertilizers.

Many are the valuable parts that Mr. John West has played in his time in connection with the gas industry; but he now came out in a new part to those present at the meeting who did not know through a personal friendship that one of his side interests is farming—and farming scientifically controlled. The paper which he read, which was the last on the full *agenda* for this meeting, and which transferred our thoughts to rural surroundings, ought, being practical experience by one who knows his subject from a double point of view, to be highly useful to makers of sulphate of ammonia, in assisting in the cultivation of the home trade in the product that is highly desirable, and more so than ever to-day. The paper shows, in the first instance, how a large estate was agriculturally turned into a commercial success by the use of lime and sulphate of ammonia. So far as spent lime goes, of course gas-works are to an extent losing interest in its agricultural virtues; seeing that the amount for disposal is a diminishing quantity, owing to the reduced necessity for using lime to eliminate the sulphur compounds from gas and (now that the luminosity of gas is not such an important matter) carbon dioxide. But sulphate of ammonia is another matter. As the Sulphate of Ammonia Committee and other authorities have shown, it must be scientifically applied in order to obtain the best results from, and therefore the best reputation for, it. It is not a fertilizer for application in any haphazard manner. From the paper we learn more of these matters.

### The Concrete Proof of Experience.

The main part of the paper treats of the successes realized by scientific treatment at a farm occupied by a member of Mr. West's family in the neighbourhood of Burton-on-Trent. The poor producing acres have been turned into lucrative ones, mainly through the aid of sulphate of ammonia. The matter was first taken in hand when advice was sought from the Midland Agricultural College, as to the best mixture for a wheat crop in a field already sown, and revealing very decided poverty. The result was a top dressing of 1 cwt. of sulphate of ammonia and 2 cwt. of superphosphates, at a cost of £1 os. 7d. per acre. Result: 55 bushels of wheat and 57 cwt. of straw per acre, both of excellent quality. The average wheat crop during the year in Great Britain was 32 bushels per acre. After this excellent result, the whole farm was scientifically treated. During the years 1910-11, all the arable land and meadows were well limed. Then follows a report on some manurial experiments made on three plots of land by the Sulphate of Ammonia Committee in 1912. For one of the plots (No. 3) the ingredients of the artificial manure included sulphate of ammonia. This plot yielded, as the figures show in the paper, more grass and hay than the other two plots—one of which had artificial manure applied, but no sulphate of ammonia; and the other was not treated at all. One cannot get away from solid facts of the kind presented in this communication. Take the total weight of hay per acre yielded by the three plots in the order in which they are referred to here: Plot 3, 2 tons 14 cwt. 1 qr. 10 lbs.; Plot 2, 2 tons 2 cwt. 3 qrs. 5 lbs.; Plot 1, 1 ton 9 cwt. 3 qrs. 8 lbs. These figures show an increase per acre of 11 cwt. 2 qrs. 7 lbs. of hay by the addition of 132 lbs. of sulphate per acre. Still further advantage was gained by treating the meadows with the following mixture (at a cost per acre of £1 12s. 6d.): 1 cwt. of sulphate of ammonia, 3 cwt. of superphosphate, 1 cwt. of sulphate of potash, and 15 loads of farmyard manure. So the good tale of success goes on right through the paper—whether dealing with grass, wheat, mangold wurzels, or other crops. Take mangold wurzels; in experimental work to ascertain the fertilizers giving the best crops, plot No. 7, on which artificial manures only were employed, gave the highest value per acre—£35 18s. 9d., as against £21 5s. on a plot (No. 1) only farmyard manured, but at a higher cost per acre. Comparing No. 2 plot with No. 7, the latter was treated to 1 cwt. more sulphate, costing 14s., which produced 7½ tons more wurzels. These are worth, after deducting 14s. for sulphate, £4 more than plot No. 2. The treatment of pasture lands (previously prepared by distributing 1 ton of fine lime per acre over them) with the following mixture, at a cost of £1 9s. 6d. per acre, has also been extraordinarily beneficial: ½ cwt. of sulphate of ammonia per acre, 1½ cwt. of sulphate of potash, 3½ cwt. of superphosphate, and 1 cwt. of common salt.

### Lime, Ammonia, and a Fine Prospect.

About the interesting features of farming, and the profitable use of one of the gas industry's secondary products, those present at the meeting heard still more. Lime, it was mentioned by Mr. West, is a most essential element in all agricultural work; without a sufficiency in the soil,

the chemical fertilizers cannot exert their full benefit, for reasons stated in the paper. Using fertilizers regularly, it is necessary and economical to apply about 10 cwt. of lime per acre per annum. Gas lime should for this purpose find a ready sale, if delivered to the farmers properly ground. As to sulphate of ammonia, Mr. West believes it will prove the most economical manure on the market; but it must be properly treated and employed. The gas industry and the Sulphate of Ammonia Committee should take particular notice of the opinion formed from experience that "sulphate of ammonia in many cases is not being sold as a suitable commercial article ready for immediate use by agriculturists." Mixtures should be made and sold as containing a certain fixed percentage of nitrogen. The hiring-out of distributors to farmers is another suggestion. As to the question of publicity for sulphate of ammonia on the lines of the work done for gas among the public by the British Commercial Gas Association, the Sulphate of Ammonia Committee are, and have for many years, been responsible for this work. The old system of farming, with higher wages and cost of living, is not the same profitable enterprise that it was; and increased profits must now be made by the aid of science. The total quantity of sulphate of ammonia mentioned in the paper as being produced in Great Britain (380,000 tons) is below the mark; the actual figure being about 420,000 tons. The 101,000 tons said to have been used in Great Britain last year should be placed at somewhere about 97,000 tons. But what a prospect is held out here by Mr. West. He says: "About ½ cwt. of sulphate of ammonia has been used, on the average, at Bushton Farm during the last three years; and if this small quantity were applied on the available land in Great Britain, ten times more ammonia would be employed than is the case at the present time." If this were so, we should have to start being sulphate of ammonia importers, instead of exporters, unless we had early resort to nitrogen extraction from the atmosphere.

**Written Communications.**

At the close of the reading of the paper, there was no time for discussion; but there fell from the President a well-deserved acknowledgment of the indebtedness of the members to Mr. West for his useful contribution. The suggestion, however, was made that communications on the subject might be forwarded for publication.

**Honorary Members.**

We now arrive at the end business of the sittings. In the first place there were honorary members to elect; and the honour unanimously fell upon the Presidents of the French Society and German Association, upon Professor A. G. Vernon Harcourt, Professor Cobb, and Mr. H. P. Maybury, the Chief Engineer of the Road Board.

**Votes of Thanks.**

Commanding attention in the next place was a perfect sheaf of votes of thanks to all who had contributed to the making of the meeting what it had been. There was one for the Lord Mayor and Corporation, a second for the Chairman and Directors of the Gas Company (which enabled the members to make better acquaintance with another of the Directors (Mr. Alfred Tyrer), and a third for the President and Mrs. Allen. They all richly deserved the votes. There were some full-bodied "hurrahs" when the President got on to his feet to reply, and more when he said that the day happened to be the anniversary of his wedding. Council, Scrutineers, the Honorary Secretary (Mr. W. E. Price), and the Secretary (Mr. Walter Dunn) were all thanked for their zeal and devotion to the work of the Institution.

**Next Year's Meeting.**

Although it is without precedent for a meeting of the Institution to be held out of London two years running, the members could not resist the invitation brought to them from the Southport Corporation and Gas Committee by Mr. Alderman Trounson to hold next year's meeting at Southport. The manner in which the invitation was put, and the eloquent support that it received from Mr. R. G. Shadbolt, simply left the members nothing to do but to accept it unanimously and cordially, accompanied by expressions of their gratitude.

So concluded the proceedings at the fifty-first annual general meeting of the Institution.

## SOCIAL AND OTHER EVENTS.

THE week in Liverpool rushed away with almost lightning speed. It really went much too quickly, because everything was so favourable and everybody was so kind to the city's visitors. The weather was of the best that Liverpool is known to afford. Sunshine greeted the visitors every morning; and there is so much to interest in Liverpool, and so many who seemed wishful to interest and to contribute to the enjoyment of the gas men and their ladies, from all parts of the British Isles distant and near. The President and his wife and daughters appeared to be almost in perpetual attendance on the members. They did not spare themselves; and geniality and a desire to serve could not have been expressed by greater or more gracious action. The Lord Mayor (the Right Hon. Herbert R. Rathbone) and the Corporation joined magnificently in the week's events; and the Chairman (Mr. H. Wade Deacon, J.P.) and Directors of the Gas Company were charming hosts. The members had the pleasure of meeting several of them in the course of the week; but those we came across at different times were Mr. Alfred Tyrer, Mr. Allan H. Bright, and Mr. Edward Lawrence—at least a couple of which names we recognize as having been associated with the Gas Company from its inception—in fact, Mr. Tyrer on the last day of the meeting mentioned the fact that the names of his grandfather and father appeared in the original Act of the Company. Many of the members also had the pleasure of meeting at the different functions Mr. Edwin Upton (the Treasurer of the Company), Mr. Theodore Garnett (the Secretary), Mr. R. E. Gibson, and Mr. Edward Allen, jun.

**Presentation to Mr. and Mrs. Allen.**

There was a very happy incident, under unusual circumstances, at the customary private luncheon, given by the President to the Council and a few friends on the first day of the meeting. The opportunity was taken of presenting to Mr. and Mrs. Allen a beautiful gift subscribed for by members of the Council and Committees as a token of their personal esteem for the President, in commemoration of his fiftieth year of service with the Liverpool Gas Company, and as a memento of the forty-first anniversary of his and Mrs. Allen's wedding-day. In making the presentation, Mr. John Bond, of Southport, mentioned the motives which had prompted them to ask Mr. Allen to accept this token of their gratitude, their esteem, and their affection. With this, he handed to Mr. and Mrs. Allen an exquisite gold cup, on ebony stand, and fittings at the top to convert it into a flower bowl. The inscription on it was: "Presented to Edward Allen, Esq., M.Inst.C.E., President of the Institution of Gas Engineers, and Engineer of the Liverpool Gas Company, with the best wishes of his colleagues on the Council and Committee of the Institution, to commemorate his fiftieth year of service with the Liverpool Gas Company; and the forty-first anniversary of his marriage.—

June, 1914." On the cup are engraved the arms of the Gas Company and of the place where Mr. Allen was born—the Isle of Man. Mr. Allen made a happy acknowledgment. He said that he always liked to be prepared when he had to make a speech; but in this case he must confess he was quite unprepared. Moreover, he considered it was a very bad precedent to make a presentation to the President. In spite of this, he was deeply touched by the sentiments which had prompted his friends to make him such a beautiful present; and, beautiful as the gift undoubtedly was, it was more the spirit in which it was given in which he rejoiced. He was indeed proud to have devoted fifty whole years to the gas industry; and doubly proud that the fifty years had all been spent in the service of one Company, and such a Company as that which he had had the honour to serve. He looked back with pleasure on these fifty years; and, as Mr. Bond had mentioned his wedding-day, he (Mr. Allen) would like to say that the greatest gift he had ever had was his dear wife, who had enabled him to know what happiness really was. At the same time, he must not forget to mention his family, which he had been proud to see well represented in the gallery at the meeting that morning. Referring to his year of office as President of the Institution, he could only say that any measure of success which had attended it was entirely due to the affection—no other term could possibly express it—which his friends in the gas industry had shown towards him. He thanked them most heartily for the beautiful gift, which he and Mrs. Allen would always treasure as most precious, and even more for the sentiments which had prompted them to give it. He hoped that it would be handed down to many more generations of gas engineers. Mr. H. Wade Deacon, the Chairman of the Gas Company, replied shortly on behalf of Mrs. Allen. Mr. W. E. Price rose to set Mr. Allen's mind at rest on the question which the latter had raised, of the presentation being a bad precedent. It was, he explained, entirely a personal gift to Mr. Allen the man, not to Mr. Allen the President.

### Visit to the Linacre Gas-Works.

During the afternoon of Tuesday, a visit was paid by some fifty or sixty of the members to the Linacre works of the Liverpool Gas Company; the journey there being made by special tramcar. The Linacre works, it may be mentioned, were designed originally for an output of 7 million cubic feet. By gradual increases of plant, and judicious utilization of available space, the capacity has been considerably enlarged. On one occasion last winter an output of nearly 14 million cubic feet was reached; and in Mr. Allen's own words, "We have not done yet." Indeed, if all available space were used up, the 27 acres allotted to the works could be made to yield 20 million cubic feet—nearly three times the output of the original plant.

The President accompanied the party round the works, and himself explained all the details in his customary clear and interesting manner. One of the horizontal retort-houses, with its Arrol-Foulis charging machines and Williams and M'Phee pushers, was first inspected. The chief feature of interest here is the "Dryco" system of cooling the coke, which was seen in operation by the visitors. Like most of the other plant, it needs no further description than that given in the supplement to the Presidential Address, as published last week. A striking feature is the amount of labour required, under present conditions, to work it; for, besides the machine man and the man at the telpher, there were others at the retort mouthpiece adjusting the containing cylinders and holding them in position. The men, however, were not in excess of the ordinary retort-house hands, and it would be quite easy to provide a carriage with gear for raising and lowering the cylinders, and holding them in position. This particular coke commands a ready sale. In fact, when asked if he always stored this coke in the open, the President said he did not store it at all, but merely left it in the yard until it could be carted away. If it happened to rain, coke of the physical characteristics of this would not absorb water nearly to the same extent as hot coke; and so little damage is done. There could be no denying the fine quality of the coke—produced from good, though unwashed, coal—its freedom from breeze, large size, and fine silvery colour being most favourably commented upon. In the domestic stove, it was explained, it can be lighted merely with paper and sticks—the same as coal.

The next visit was to the water-gas plant, where the President explained the new mechanical clinkering arrangement. At present no figures can be given as to the working of this; but it seems to be operating with entire satisfaction. Succeeding was the formal inauguration of the new 2½ million cubic feet Glover-West vertical retort plant (described elsewhere in this issue), which ceremony was performed by Mr. John Bond, of Southport. He caused merriment by remarking that in this case it was not necessary to break a bottle of champagne, since, with this system, no coke-quenching was necessary. He congratulated the President on being up-to-date with his carbonizing plant, and the contractors on the excellent progress made with their system. Wishing good luck to this particular installation, he started-up the motors which work the coke-extractors, and connected-up the shafting. After this, Mr. Fred J. West, of West's Gas Improvement Company, supervised the first draw of cooled coke from the hoppers, which was successfully accomplished. In the horizontal house with Fiddes-Aldridge machinery, another ceremony was performed, when the Chairman of the Gas Company (Mr. H. Wade Deacon) pluckily mounted the charging-machine, and, acting under the guidance of a swarthy stoker, filled a retort—thus installing the continuous chain designed to ensure a full charge. Mention must also be made of the electric-meter, which is described by the President in the appendix to his address; and as was seen by a paragraph in the "JOURNAL" last week (p. 761), a long description has also been published by Professor Thomas himself. The meter, a novelty to most of those present, was examined with interest; and it was satisfactory to hear that the preliminary difficulties seem to have been overcome, and that good results are now expected from its working.

At the conclusion of the inspection, tea was served in the offices of the works; the return journey to the city being made by tram car. The members were unanimous in their praise of the works, and their excellent arrangement. Under the able pilotage of Mr. Allen, they all saw something to interest them, and very little to criticize. The thanks of the members are due to the President for the way in which he explained his works (of which he is obviously and justly proud), and answered the numerous questions which were fired at him from all sides.

### Reception by the Chairman and Directors of the Gas Company.

Everything in the way of entertainment succeeded during the week. The reception and dance on Tuesday evening, at the Adelphi Hotel, on the invitation of the Chairman (Mr. H. Wade Deacon, J.P.) and Directors of the Gas Company, did so in the fullest sense of the word. The reception was timed for 8.30; and from then onwards, Mr. Wade Deacon and his sister, Mrs. Hodgson, together with the President and Mrs. Allen, were kept busy receiving their guests. Seeing there were 731 acceptances, there was no lull in their pleasant duty until it was completed. The scene in the halls, the ball room, and the music room was a brilliant one. The huge throng was alive with the animation of genuine pleasure. The dancing-room was well patronized, though the heat and the exercise had a very bad effect on the ladies' coiffures, and on the gentlemen's collars. There was a plentiful mopping of faces after each dance, and the iced drinks at the refreshment tables were in huge demand. But the votaries of Terpsichore only realized fatigue when the midnight hour struck and the National Anthem was played by the band. For those who preferred the more sedate pleasure, there was music and song by a concert party, comprising Mrs. Robert Walker, Miss Hilda Cragg-James, Mr. Douglas Milton, and Mr. Herbert Morris, as well as the Minster Vocal Quartette: Mr. Harold Yates, Mr. Tom Barlow, Mr. W. H. Atkinson, and Mr. Fred Owens. It was a glorious evening; and if not formally expressed at the time, the heartiest thanks were felt to the Chairman and Directors of the Company for their generous entertainment.

### A Second Reception and Dance.

The scene changed the following evening. It was at the Town Hall; but the visitors were not by any means tired of entertainment of the order to which they had been graciously invited—this time by the Lord Mayor and Lady Mayoress. The acceptances in this instance numbered 693. The guests were received by the Lord Mayor and Lady Mayoress

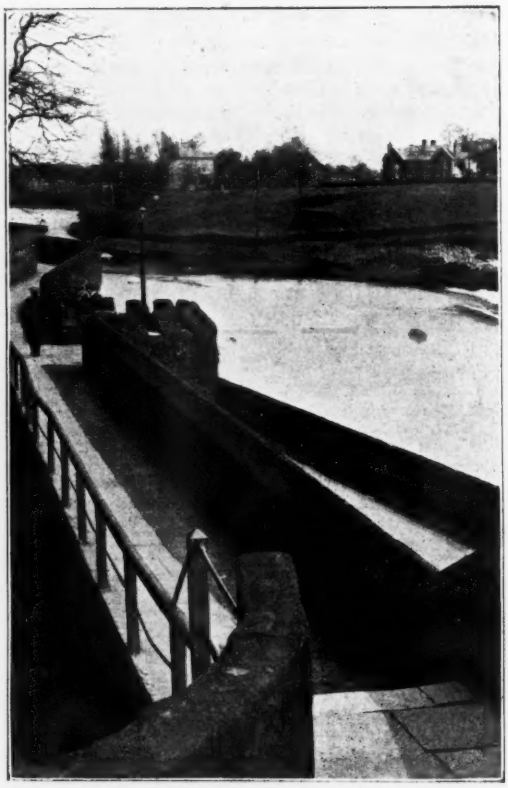
—his Lordship being in Court Dress. There was again dancing; but many found pleasure in wandering through the beautiful halls, lighted by magnificent electroliers, and examining the pictures and other works of art, and a wealth of old-time silver. The entertainment lasted until eleven o'clock; and again there was regret when the final item of the programme had been reached.

### A Sail on the Mersey.

On Thursday afternoon there was a steamer trip on the Mersey, at the invitation of the President and Mrs. Allen. A large detachment of members—549 was, we understand, the number accepting—availed themselves of this excellent opportunity of obtaining a general view of Liverpool's wonderful docks; among other items of interest which were passed on the way being the new White Star liner "Aquitania." The weather was fine, though somewhat dull, when the "Flying Kestrel" left the Prince's Landing-stage soon after 3.30, and made her way down stream as far as the "Bar," passing New Brighton and several other townships occupying the left bank of the river. On the return journey, Liverpool was passed on the left, and Birkenhead, Rock Ferry, New Ferry, Seacombe, and Port Sunlight were seen on the right. All were sorry when the time came to turn once more towards the Prince's Landing-stage, where the party disembarked after a most enjoyable sail, which was rendered all the more agreeable by the kindness of the elements—sea and sky. Afternoon tea was served on board, and selections of music were well rendered by a brass band, the nucleus of which was provided by musicians from the gas-works. Their rendering of "Auld Lang Syne" was especially popular.

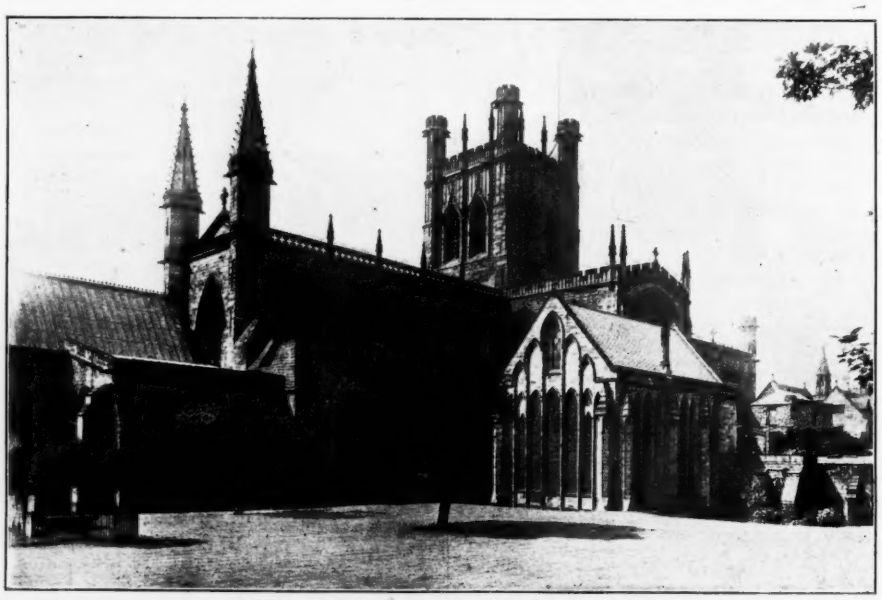
### At Chester and on the River Dee.

The first peep from the window on Friday morning was to see what the day promised. The sun was shining brilliantly; and it continued throughout the day to shed its exhilarating rays on the huge company who had signified their intention to take part in the trip to Chester and Eaton Hall. It is a favourite excursion; and, all told, no less than 423 persons took part in it, including the President (Mr. Edward Allen), Mrs. Allen, and their family, the President-to-be within a few hours (Mr. John Bond) and Mrs. Bond, the Hon. Secretary (Mr. W. E. Price) and Mrs. Price, and that most energetic of Secretaries (Mr. Walter T. Dunn). We were a big—the numbers tell that—decorous party, yet full of the bright spirit of the day, that boarded a special train at Lime Street Station for Chester. Though the train was a "special," it was not by any means an express one; but the time passed quickly, for all seemed to be bent on securing from the outing the maximum of enjoyment. On Chester Station platform we found Mr. J. C. Belton, the Engineer to the local Gas Company, waiting for the visitors. Outside the railway station special tramcars were provided; and soon we were running through the famed old-world streets of the beautiful city. From the cars the company alighted close by the Cathedral, which the greater number visited; a smaller number desiring to take advantage of the opportunity of exploring the ancient city walls, which are some 2 miles in length. Whichever the choice, there was good reward in an abundant interest. Round the fine Cathedral, the associations of which carry one back more than a thousand years, the visitors were kindly escorted



THE CITY WALL AT CHESTER.

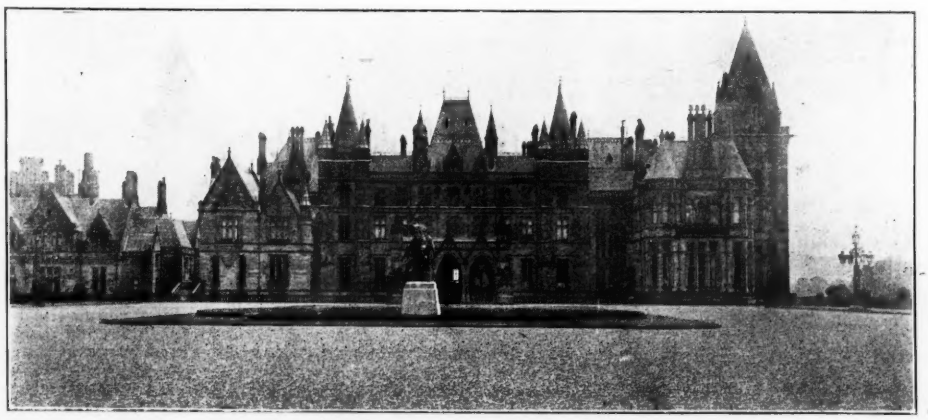
by the Precentor, the Rev. Harold Wright; and his fund of information about the ancient pile appeared to be almost inexhaustible, judging from the information he gave and the readiness with which he answered the inquiries with which he was plied. While there, Dr. Bridge delighted the visitors by giving them a selection of music on the grand organ. The celebrated organist subsequently remarked that he was glad the visitors had heard his organ; whereupon the President gave the reply courteous and



CHESTER CATHEDRAL AND CHAPTER HOUSE.

complimentary that the visitors had not been to hear the organ, but to have the happiness of hearing Dr. Bridge on the organ. The principal of the parties touring the walls was conducted by Mr. W. Simpson, who was brimful of information on all points of interest.

Afterwards the forces were again united; this time for luncheon in the fine Town Hall. There they met his Worship the Mayor (Alderman J. Meadows Frost, J.P.), who is Chairman of the Chester United Gas Company, and the Secretary and General Manager, Mr. F. A. Pye. Among those at the top table were, in addition to the President and the Mayor, Mrs. Allen, the President-elect, and Mrs. Bond, the new Senior Vice-President and Mrs. Young, and Mr. and Mrs. Councillor Kay, of Manchester. The Chairman of the Council of the Society of British Gas Industries (Mr. J. W. Broadhead), and many of his colleagues on that Council, were also present. From this time onward during the day, the Mayor, Mr. Pye, and Mr. Belton accompanied the visitors, and were diligent in ministering to their enjoyment.



FRONT VIEW OF EATON HALL.

THE CHAIN FERRY AT ECCLESTON.

After lunch, the loyal toast was honoured.

Mr. JOHN BOND then proposed the "City of Chester." He said that he knew very little of the city; but, as all the world was aware, it was an ancient and historic city; fortunate in possessing a modern gas-works, an up-to-date Chairman, Secretary and General Manager, and Engineer. The Engineer was a past-President of the Manchester Institution, and was a man who had done good work in the industry. He did not know much about the other industries (if there were any) of Chester; but he had been informed that the city was noted for Dee salmon. [Laughter.] They had had some that day; and they must all admit that it was very enjoyable. The Mayor was to respond to the toast; and he would be able to tell the visitors more about the city than he (Mr. Bond) could possibly do. Those of them who had visited the beautiful cathedral that morning, had not only admired the ancient pile, but the music they had heard had filled them with delight.

The MAYOR thanked those present for the kind and cordial manner n which they had received the toast. The city was a popular resort; and he was sure that, with such a fine day, the visitors would inspect the historical remains with very great interest. He might briefly say that Chester was one of those old cities founded by the Romans, who for four centuries ruled the destinies of our land. In those days it was a place of the first importance in North Britain. After the departure of the Romans, the centuries of the middle ages witnessed incessant struggles, in which the district played a prominent part. The city owned many relics of the past; and a visit to the Muniment Room in the building would show them many ancient charters—notably about the time of Henry II.—granting many important franchises and privileges to the city. No visitor walking through the town could fail to see innumerable relics of the past, of which the citizens were justly proud. The City Walls were characteristic of Chester; and no other city possessed such unique rows. There was no need for him to draw attention to the stately Cathedral, the architectural features of which were scarcely less interesting than its history. On the way to the river in the afternoon they would pass the historical and interesting Church of St. John, with its picturesque ruins. In the Chester of to-day, the visitors would find more a residential city than one of manufactures; and he believed that, during the day they were spending there, they would be pleased with what they saw, and consider the relief from their labours had been profitably employed. He would not say more on the subject, but would proceed to the toast which it was his honour to propose. It was that of "The Institution of Gas Engineers," It was most gratifying to know that the members had had one of their most successful and enjoyable conferences in Liverpool; and it was with the greatest of pleasure they now welcomed them all to this ancient city on the termination of the business meetings. The Institution had, he saw, arrived at a good sound middle age; and with its vigorous offshoots—Research Committees, District Associations and Commercial Sections, and the British Commercial Gas Association—its power and usefulness were enormous. There could be no doubt that the feeling of comradeship and the spirit of emulation engendered and encouraged by the personal intercourse and association afforded by such an Institution had the most beneficial and far-reaching results; and, fortunate though they were in securing the active co-operation of the best-educated and most scientific minds engaged in the profession, he did not doubt that the members individually would admit having secured personal advantage through their association. They had undoubted cause for pride in the connection with the Institution of such gifted and able men as Sir Corbet Woodall, Mr. Charles Carpenter, Professors Smithells, Dixon, and Bone, Dr. Hans Bunte, and Mr. Dugald Clark; and he knew the dignity of the office of President must have been fully maintained during its occupancy by Mr. Allen, who had that most essential requisite qualification—a combination of sound engineering ability with an exceptional degree of executive and commercial ability. He ought here to acknowledge the frequent kindnesses and assistance Mr. Allen had afforded on different occasions to the Chester Company. He (the Mayor) thought the members were well entitled to congratulation upon the efforts made (which had been referred to in the annual report and in the presidential address) to encourage education of the staffs employed in the industry. The inclusion of gas-fitting in the Department of Technology of the City and Guilds of London Institute was an excellent idea; and although it might possibly happen that just at first those engaged in this branch of the industry might not take such full advantage of it as could be wished, he was quite sure that men of such enthusiastic interest in their profession, as was shown by the results recorded in the annual report, would eventually succeed in transmitting their enthusiasm to the staffs working under their guidance, and that shortly the gas-fitting examinations would be one of the best patronized in the whole most useful series of the Institute's Technology Department.

EASTGATE, CHESTER.

For the study of the higher scientific branches of its work, he saw the gas industry had most wisely endowed a Chair in the Leeds University, and founded a scholarship. While referring to this matter, might he congratulate the members upon the excellent lecture given by Mr. Carpenter on the subject of "Sulphur Purification." [Cheers.] This was, he thought, one of the most important questions under consideration at the present time, as they all realized that, quite apart from legal obligations, the interests of users and suppliers of gas were identical, so far as the supply of a pure uniform quality of gas was concerned. Only by the supply of gas at uniform pressure, and of even quality, free from sulphur impurities, which were liable to corrode fittings, could they hope to maintain the lighting load which the electrical competitors were so anxious to secure. In conclusion, he expressed his pleasure in observing that the Institution had a Benevolent Fund in active operation. He hoped it would receive all the support which its high objects deserved. It was gratifying to see that their old Chester friend, Mr. Fletcher Stevenson, now of Coventry, had just been placed upon the Board of Management. With the heartiest wishes for success, he had great pleasure in asking all to rise and drink to the prosperity of the Institution; and he coupled with the toast the names of Mr. Edward Allen, of Liverpool, the retiring President, and Mr. W. E. Price, of Hampton Court, the popular Honorary Secretary.

The PRESIDENT said it was an honour to have to acknowledge a toast so ably proposed, and so enthusiastically received. He had no hesitation in saying that the toast had never been proposed in an abler speech than that to which they had listened that day. He (the President) was disposed to ascribe the cause of this to the very important fact that his Worship was also the Chairman of the Chester Gas Company. [Cheers.] His Worship's speech was a worthy contribution to the proceedings at their annual session. The wise remarks made in connection with the gas business were worthy of being printed, and considered as part of their proceedings. As Mayor of Chester, they were delighted to have Alderman Meadows Frost with them. To come into the city, and to be received by the Mayor, made the place so much more charming; and they one and all thanked his Worship for the courteous way in which he had welcomed them. They also appreciated most highly the officials of the Gas Company. In Messrs. Pye and Belton they recognized men who were able to maintain in the ancient city the supremacy of gas as a light, heat, and power agent. He desired to express, on behalf of the members of the Institution and their ladies, their sincere thanks for the assistance of these gentlemen in arranging for the visit. It was by no means a simple matter to arrange the details for such a party, for they had, in addition to inspecting the cathedral and listening to the beautiful harmonies produced by Dr. Bridge, visited the walls of the city, and were to sail up the river to Eaton Hall. This meant a large amount of detail work, and in this Messrs. Pye and Belton had done so much. The Institution had, indeed, arrived at quite middle age; but he did not think that years had any effect upon such an Institution as theirs. It appeared to him that there were fresh fields to acquire, and new triumphs before them. And when some years hence—say, twenty years or so—they remembered the day, they would realize that the hope and prophecy were good ones, and that there were still better and better days before the industry. He would leave their Hon. Secretary, who was the worthy successor of worthy predecessors—Messrs. Shoubridge and James W. Helps—to continue the response. The Institution were going to have the services of Mr. Price for another year; and he (the President) was delighted to know these services would be ably rendered. [Cheers.]

Mr. PRICE thanked those present for the way in which they had received the flattering remarks made by the President. Their President had a habit of saying nice things, and in a nice way. He (Mr. Price) was pleased indeed to be associated with the work of the Institution; and all he could do he would do. What he had so far done had been with all pleasure imaginable.

Mr. JOHN YOUNG proposed the toast of "The Ladies," and Mr.

GROUP OF MEMBERS TAKEN AT "JIM O' THE BOATS," ON THE DEE.

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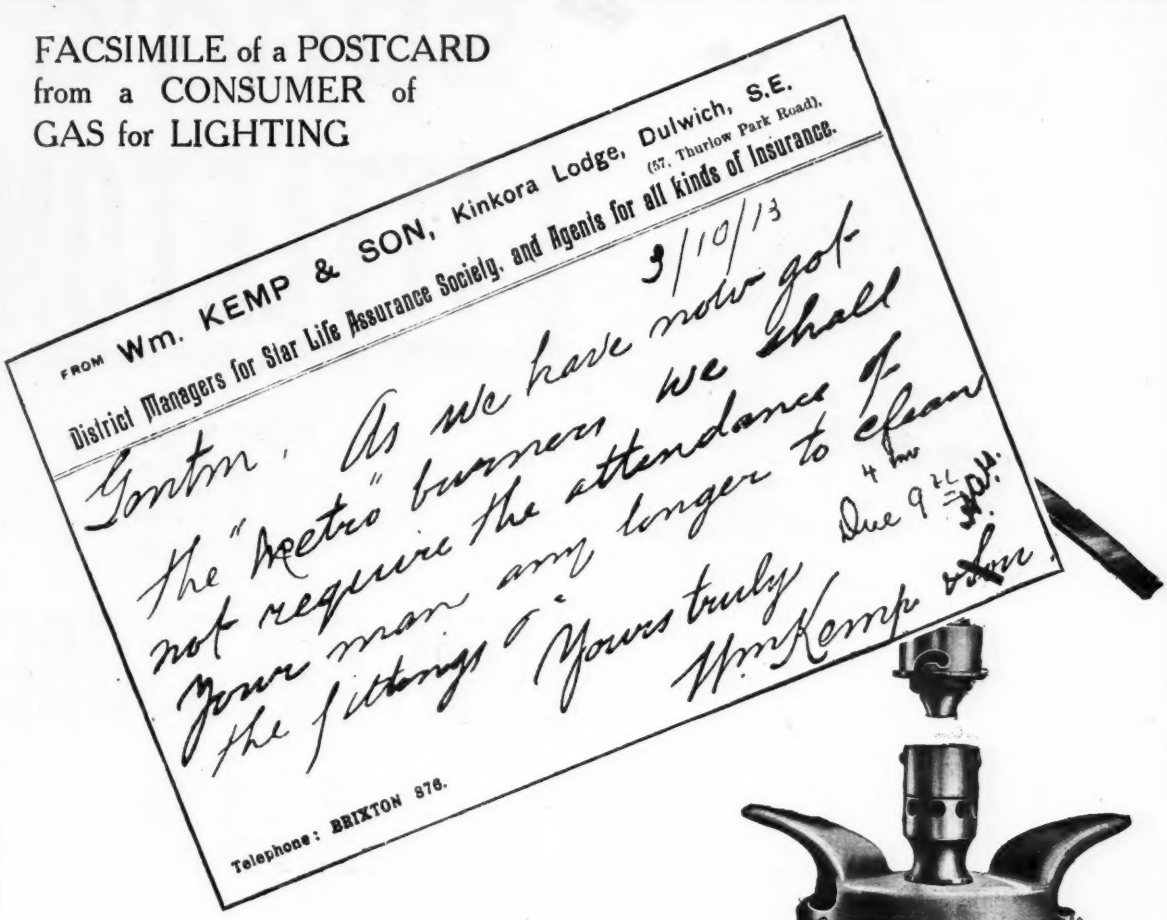
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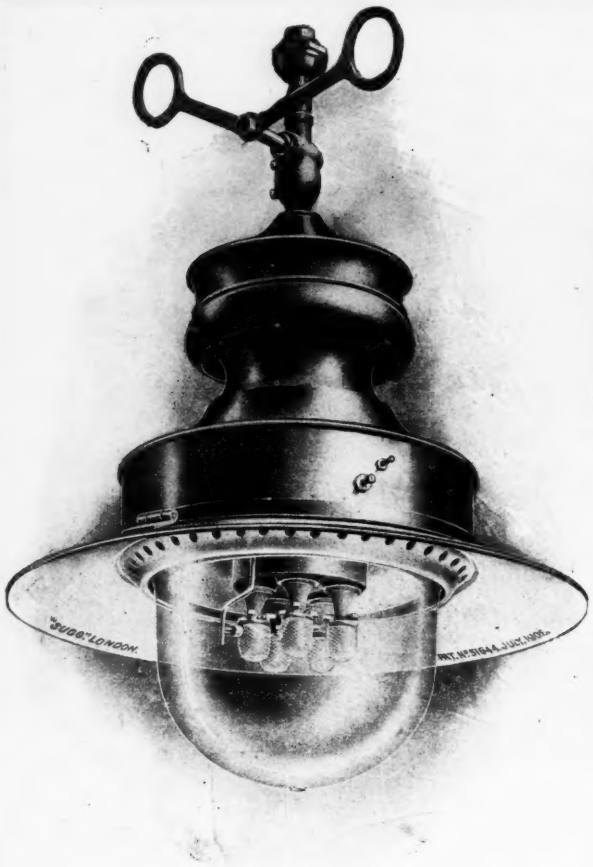


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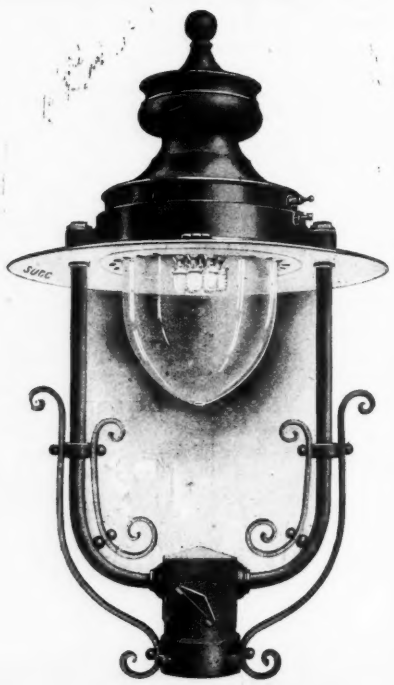


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Robert Watson responded on their behalf. Both gentlemen made humorous speeches, and gained invisible laurels from the ladies.

By a "fleet" of special steamers from the "The Groves," the visitors were taken along the Dee; the charming scenery on both sides delighting and eliciting the admiration of all. At the Iron Bridge, Eaton Hall, they landed; and, by the invitation of His Grace the Duke of Westminster, they walked through the grand park, and afterwards through the magnificent rooms and corridors of the Hall itself. It was quite 4.30, if not later, before the river was again reached; the *rendezvous* this time being Eccleston Chain Ferry. Crossing by the ferry, tea was served at "Jim o' the Boats," which is beautifully situated on the bank of the Dee. The members were here the guests of the President and Mrs. Allen. After tea, a photograph was taken of the major part of the happy company. Crossing the ferry again, a short walk along the bank brought the visitors to their boats. But before leaving the bank, a hearty vote of thanks was passed, and three cheers given, to the President and Mrs. Allen for their hospitality. All too quickly, we arrived once more at Chester. There was then best part of an hour and a half to spare in which to make further explorations in the city before the "special" started for Liverpool. It was a delightful day; but the best of such days—and this was one of them—must have an ending. At Liverpool, adieus were said to the President and Mrs. Allen; and so we informally passed from the old presidential year to the new. The best wish for Mr. John Bond is that his year of office may certainly be as successful as that of Mr. Allen.

# THE BENEVOLENT FUND.

## MEETING OF DONORS AND SUBSCRIBERS.

On Wednesday morning, the Annual Meeting of the Donors and Subscribers to this Fund was held—the President in the chair.

The minutes of the previous meeting having been confirmed,

The President said: Gentlemen, we have now to hold a meeting in connection with the Benevolent Fund. I see the report is "in the pink." The fund is not quite "in the pink." But it is all right; and after the efforts that you will make to-day I have no doubt everything will be rosy. I propose that the report of the Committee of Management for 1913-14 [*ante*, p. 640] and the Statement of Accounts be accepted.

Mr. Samuel Glover (St. Helens): I have great pleasure in seconding the resolution.

The resolution was carried unanimously.

The President: Now, gentlemen, I invite any observations you may have to make on the working of the fund.

Mr. J. Ferguson Bell (Derby): Mr. President, I should like to say a word, as one who has been a member of the Committee for many years, and as one who knows the beneficent work that is accomplished by the fund. I notice that the total number of subscribers to the fund is only 273. Seeing that we have something like 900 members in the Institution, I do not think we can say this is altogether satisfactory. As one who has had experience of what has been done by the fund, I earnestly commend it to any members who have not so far subscribed to it, and assure them that it will amply repay them in the good that it will do. I know of one case that has recently been brought vividly to my mind. One of our members who in his lifetime could not possibly make provision for his wife and family, was taken away; but by means of the fund, his wife is able to educate her sons, and I believe they will in due course become gas engineers. This is only one case within my own knowledge. We as a Committee, of course, do not make known the work that has been done. I am, no doubt, now preaching to the converted; but I would like to say to the members present that they might take an opportunity now and again to mention to their friends the desirability of being subscribers, if only for a small amount. At this stage, I should like to refer to the death of our friend Mr. Charles Meiklejohn, of Rugby. For a number of years he was the Secretary of the Midland Association; and in this capacity he took a most earnest and active interest in the fund. He was the means of getting a large number of subscribers to it; and I would, therefore, desire to be associated in an expression of regret at the great loss we have sustained by his death. In the same way, I should like to refer to the death of our old friend Mr. Newbigging.

Mr. J. C. Belton (Chester): Mr. President, I do not think it is sufficient for us merely to express an opinion with regard to the number of subscriptions the fund has already received from the members. I think something more practical should be the result of what has been said; and I would suggest that the Secretary should be requested to circularize all those members who have not hitherto subscribed. If a personal appeal were to be sent to each non-subscriber, I think it would have a much better effect than any resolution we might pass here.

The President: It is quite clear, gentlemen, that all that has been said on this subject was to the point. I would just repeat the suggestion, as I understand it, which has been made. First of all, the number of subscribers is certainly insufficient, and is not at all in due proportion to the number of members of the Institution. The fund needs your support, there is no doubt. I have attended nearly all the Committee meetings during the past year; and I may say that we have fortunately been able to deal with the cases that have come before us. But we could have dealt with them rather more generously if the fund had been in a better condition. I feel quite certain that the Institution would be lacking in its duty if the fund were to be in any way neglected. Then the second idea is that, as a means to this end, Mr. Belton suggests we should circularize the members who have not yet subscribed; and I think this course would commend itself to the Committee. With regard to our late friend Mr. Meiklejohn, I was a member of the Committee when he was Secretary; and I remember on that occasion a very special effort was made by the Midland Association. Other Associations may consider whether it would not be a proper and necessary thing for them to deal with the fund in their own districts. Decentralization has its advantages. You can do more with your own members than can possibly be done by any printed circular sent out by the Committee. The next business is the election of two members of the Committee of Management.

Mr. John Young (Hull): Mr. President and gentlemen, after very careful consideration, the Committee of Management have nominated for your election Mr. D. Irving, of Bristol, and Mr. Alexander Wilson, of Glasgow. In considering who should be nominated, it was felt to be very desirable that the Committee should be representative of the various districts embraced by the whole Institution; and you will notice that the south-west and the southern district will be represented by Mr. Irving, and the north by Mr. Wilson. I hope, gentlemen, that these names will meet with approval. I have pleasure in proposing that they be elected members of the Committee of Management.

Mr. S. Y. Shoubridge (Lower Sydenham): I should be very happy to second that proposal.

The resolution was carried unanimously.

The President: This, gentlemen, ends the business of the Benevolent Fund.

# GENERAL REPORT.

THE Annual General Meeting of the Institution opened last Tuesday, at St. George's Hall, Liverpool—Mr. EDWARD ALLEN, M.Inst.C.E., Engineer to the Liverpool United Gaslight Company, the President, in the chair.

## Welcome by the Lord Mayor.

The proceedings commenced with a welcome by the Lord Mayor of Liverpool (the Rt. Hon. Herbert R. Rathbone, J.P.) and the Chairman of the Liverpool United Gaslight Company (Mr. H. Wade Deacon, J.P.).

The LORD MAYOR: Ladies and gentlemen, my most pleasing duty this morning is to offer a very sincere and hearty welcome to the members of the Institution of Gas Engineers on their visit to Liverpool, and to express the hope that your visit here will not only be extremely profitable and useful to the work in which you are engaged, but that it will also prove enjoyable. I am happy to think that the "Clerk of the Weather" on this occasion has been so very kind as to favour us with a fairly large sample of fine weather. The Americans say that we do not have weather in England, but only samples. On this occasion, we look like having a fairly substantial sample. The subjects you are here to discuss are of immense importance and interest, not only to those present, but also to a very much wider circle, because the questions which are involved are questions which not only vitally affect our commerce and industries, but also the health of the population. I think that I might, perhaps, go a step further, and say they affect very much the æsthetic appearance of our cities, because I have always felt myself that, if it was possible to make gas more largely than it is at present the means of heating our houses, and of supplying the heat that is required for other purposes, we might combat to some extent that dreadful plague, the smoke nuisance. ["Hear, hear."] I have recently occasionally taken my lunch at the top of a very high building in Liverpool, and have thus had an opportunity of surveying apparently the greater part, at any rate, of the roofs of the city; and one cannot fail to be impressed, when one is up there, with the enormous amount of smoke which comes apparently from the fires that exist for domestic purposes. It does not seem that in Liverpool, at any rate, the smoke nuisance is mainly caused by factories. As far as one can gather by a casual survey from the top of a building of this kind, it is mainly due to the smoke that comes from the private chimneys of houses and offices, where, of course, the fires are used for ordinary heating and domestic purposes. If one could combat this, what an enormous difference it would make in the appearance of our cities, and in the cleanliness of our people. It is almost pitiful to see what a difficult task it is to keep clean in a city like Liverpool, or in any of the big manufacturing towns. You seem to have to spend the whole of your time in washing, if you wish to remain only tolerably clean. One hardly knows just where all the dirt comes from; but it seems to pervade and search out every corner. If you, gentlemen, in the industry in which you are engaged, can help in solving this serious problem, which so much militates against the health and happiness of our people, you will have rendered a great service to the community; and I hope in doing so you will not have been neglectful of your own interests. I am not here really to-day to express any of my own views on such a subject, but, as I have said before, to express the appreciation of the City of Liverpool at your having chosen the city this year for the purpose of holding your congress and carrying on your deliberations, and to express the hope, as I have already done, that your deliberations may prove useful, and that your stay in Liverpool may be enjoyable. [Applause.]

Mr. H. WADE DEACON: My Lord Mayor, Mr. President, ladies, and gentlemen, on behalf of the Liverpool Gas Company it is my pleasing duty to offer to the Institution of Gas Engineers a very hearty welcome to the City of Liverpool. The Lord Mayor has offered his welcome as the Chief Officer of the city; and as the Chairman of the Gas Company I wish to join with him in welcoming you, and in hoping that you may have a profitable and enjoyable time. I believe it is 35 years since the Institution had their last annual meeting in this city. It is particularly fortunate that your meeting should be held here this year, when your President for the time being is the Engineer of the Gas Company. It is an honourable position; and from what I have seen of the amount of time which is required to be devoted to the work of the Institution by the President, it is also an onerous position. If I may, I should like to congratulate the Institution on having a most able and energetic President; and I would also congratulate the President on having been able to secure the votes of his fellow professional men for his election as your Chief Officer. It is an honour on both sides; and the Liverpool Gas Company are pleased that their Chief Engineer should have been your President. I do not propose to take up any more of your time, as you have an enormous amount of work to do—so I have been told, and I quite believe it. [Laughter.] Therefore, I will simply wish you, on behalf of the Liverpool Gas Company, a very pleasant and profitable time while you are here. [Applause.]

The PRESIDENT: My Lord Mayor, Mr. Wade Deacon, ladies, and gentlemen, at a meeting of the Council held last evening, I was requested to submit a joint vote of thanks to this meeting, and to ask his Lordship and Mr. Wade Deacon to accept the vote. The words of the resolution are as follows: "That the President convey to the Lord Mayor (the Rt. Hon. Herbert R. Rathbone, J.P.) and to the Chairman of the Liverpool Gas Company (Mr. H. Wade Deacon, J.P.) the best thanks of the members of the Institution of Gas Engineers for their great kindness in attending the opening meeting and offering such a hearty welcome to the members on this occasion." It affords me the greatest possible pleasure to present this joint resolution of thanks. The kindness of his Lordship, and his interest in everything that is associated with the progress of Science and Art, is traditional, not only in regard to his high office as Chief Magistrate of the city, but as a member of a family that is famous for its interest in education and the social betterment of the citizens of Liverpool. His Lordship has been good enough to recognize the importance of the gas industry to the business and social life of the community, and the value of the Institution in assisting those in charge of gas undertakings to carry out their operations in the most efficient manner. We beg to assure his Lordship of our keen interest in the industry, and our pride in its present flourishing condition, and of our determination to extend its usefulness. We sincerely thank his Lordship for the kind way in which he received us some time ago when we waited on him, and for the reception at the Town Hall we are to enjoy to-morrow evening, which will no doubt greatly enhance the pleasure and enjoyment of your visit to Liverpool. With regard to the Chairman of the Gas Company, who is my honoured Chief—and no engineer could have a better chairman—the members of the Institution gladly accepted the invitation to visit Liverpool which he gave at the last annual conference, and are grateful to him for so cordially welcoming them at this morning's meeting. Speaking purely on behalf of the Institution members, we are most grateful to the Chairman and Directors of the Company for the very great amount of consideration they have given to me, your President, in carrying out the onerous duties that he has already referred to. My Lord Mayor, will you please accept our very grateful thanks? Mr. Wade Deacon, will you also accept our very grateful thanks? [Applause.]

The LORD MAYOR: Mr. President, ladies, and gentlemen, it is indeed very good of you to have thanked us in such very cordial terms for having come here this morning, and having endeavoured to do our small part in making your visit to Liverpool a success. I can only say if we contribute to the success of this meeting, we shall be amply repaid for any little trouble we may have taken. It is my duty now to make way for the gentleman who will preside over your proceedings after I have gone, because I am sorry to say that I have other engagements at the Town Hall which will deprive me of the pleasure of listening to the deliberations myself. I unfortunately have rather a busy day before me, or else I should have stayed, and would have

endeavoured to understand what may prove a technical discussion. I daresay I should have listened with a great deal of interest. [Applause.]

### The Late Mr. Thomas Newbigging, D.Sc., and the Late Mr. John Chew.

The PRESIDENT: Ladies and gentlemen, it is with extreme regret that I have to bring before you, as the first business of this conference, the matter of the great losses sustained by the Institution by the death of Mr. Newbigging and our old friend Mr. John Chew, of Blackpool. There is an obituary list given in the report of the Council; but since the report was printed we have learnt of the death of these two great men. Mr. Newbigging filled a very important position in the gas industry for many years. He was known to all of us, because he took a great and deep interest in the proceedings of the Institution. The last occasion on which I had the pleasure of meeting him was in Scotland, when a tablet to the memory of William Murdoch was unveiled; and I was, as ever before, charmed with his brightness, his keen intellect, and the very broad manner in which he dealt with all questions belonging to our industry. He has passed away. A tablet to his memory is erected in the minds and hearts of every one of us. We shall look back upon his life with very great admiration; and I will ask you this morning to express your deep sympathy with his relatives by rising in your places.

All the members rose silently.

The PRESIDENT: Thank you, gentlemen. With regard to our late member, Mr. Chew, it cannot be said that he was able to fill a great position; but he did his duty for many years in the service of the Blackpool Corporation. He carried on this work in a manner most satisfactory to his own town; and the members of the Institution always regarded the Blackpool undertaking, under the government of Mr. Chew, as being a model one. We have lost him. He has completed a long life of excellent service; and we desire to express to his relatives our sincere sympathy with them in their bereavement.

The members rose in their places.

### Confirmation of the Minutes.

It having been moved and seconded that the minutes of the last annual meeting should be taken as read and adopted, the President signed them.

### Distinguished Visitors.

The PRESIDENT: Among our distinguished visitors, we have with us this morning Dr. Elliott, of New York, who desires to address you. [Applause.]

Dr. A. H. ELLIOTT (New York City): Mr. President and gentlemen, it is my pleasure to be the bearer of an invitation from the Panama-Pacific Congress of Gas Engineers to all the members of this Institution; and in connection with the matter, I should like to read a letter received from the Secretary setting forth the arrangements that have been made for the convenience of visitors to San Francisco next year:—

*June* 1, 1914.

Dear Dr. Elliott,—Referring to the International Gas Congress which is to be held in San Francisco during the week beginning September 27, 1915, in connection with the Panama-Pacific International Exposition, I am giving you such information as we have on hand at the present time in regard to this congress. While it may vary a little from the tentative programme that I shall give you, it is approximately correct.

We expect to have our members and those who attend the congress go from New York City and from Chicago (Ill.) in special trains. The return trip from San Francisco will doubtless be made on regular trains; but in case a sufficient number can be grouped who desire to return by the same route, special cars may be arranged for.

I enclose a list of the foreign Gas Societies to which courteous invitations have been extended; and we sincerely hope to have representatives from each of these Gas Societies, and would like very much indeed to have a paper on some appropriate subject from each of the Societies—particularly the English, German, and French Societies.

The time of the year will be exceedingly appropriate, as travel and climate will be at its best at that particular time. The work has progressed sufficiently to state that we shall have a large attendance; and we hope to have a Gas Congress international in character, and of great importance to the future of the gas industry.

There will be a remarkable exhibit of outdoor gas lighting under high pressure; and there will be a number of novelties which will be of interest to the gas fraternity. Everything that can be done to make the visit of the foreign delegation pleasant and profitable we shall endeavour to do; and we sincerely hope for a corresponding representation from abroad.—Yours very truly, THE SECRETARY.

I hope we shall see many from this Institution. We shall do our best to give you a hearty welcome. We will take you everywhere we can; and there will be lots to help us. We are very sincere in what we say in wishing to give you a hearty welcome. It will be an extraordinarily cheap trip, considering the distances you will travel; but you will scarcely realize these distances, because we travel so fast.

The PRESIDENT: I am sure we are all very much obliged to Dr. Elliott for imparting to us this information. In giving us the details he has done, he seems to indicate that he expects all of you to go, and that you only want to know what the expense will be. However, we must all try and save up enough to go next year. Dr. Elliott, in enumerating the many attractions of such a visit, has not spoken of the greatest attraction—namely, the opportunity of thus meeting with our colleagues in America, and becoming acquainted with the very excellent methods of carrying on the gas business there.

### Appointment of Scrutineers.

On the motion of Mr. JOHN YOUNG (Hull), seconded by Mr. THOMAS BERRIDGE (Leamington), Mr. G. S. Frith, of Runcorn, and Mr. John Terrace, of Grimsby, were appointed Scrutineers.

### Colleagues in France.

The PRESIDENT: It is now proposed to send a telegram to our colleagues in Paris, the Société Technique de l'Industrie du Gaz en France, who are meeting in Paris to-day. It is very unfortunate; and it had been hoped that our dates would not have clashed. It has been suggested that the following telegram should be sent: "Cordial wishes for successful meeting from your British *confrères*, the Institution of Gas Engineers, meeting at St. George's Hall, Liverpool."

The resolution was carried unanimously.

### The "London" and Institution Medals.

THE "LONDON" GOLD MEDAL AND THE INSTITUTION SILVER MEDAL.

The PRESIDENT: To Dr. W. B. Davidson, of Birmingham, is awarded the "London" gold medal, for his paper on "Liquid Purification." It is better known, I think, as Mr. Jones's medal, and is given to the author of the paper that indicates the most interesting and important matter connected with the manufacture and distribution of gas. In presenting this medal to you, Dr. Davidson, I would refer to the indebtedness of the Institution to the important undertaking you represent. I mean the Gas Department of the Corporation of Birmingham. We have become indebted to officials connected with the undertaking for very important papers. Last year we had more than one. This medal is awarded to you in recognition of the skill and ability you have displayed in connection with the paper you contributed on that occasion. There is another medal to be awarded to Dr. Davidson, and that is the silver medal for his paper on "Liquid Purification." The awards of the Institution medals are quite distinct from Mr. Jones's medal.

The medals having been presented,

Dr. W. B. DAVIDSON (Birmingham) said: Mr. President, ladies, and gentlemen, I wish to thank you, Sir, for your very kind words of congratulation. I should like to say that when I wrote my paper on "Liquid Purification," I had no visions of either gold or silver medals. The paper had to be written, and I did it. With you, Sir, I should also like to express my indebtedness to the Birmingham Gas Committee, who have given every encouragement to gas engineering research; and to thank my lucky stars that

nine years ago I was able to transfer my services to Birmingham, where I was allowed unique opportunities.

THE INSTITUTION GOLD MEDAL.

The PRESIDENT: The Institution gold medal has been awarded to Mr. W. Chaney, likewise of the Birmingham Gas Department, for his paper on "Coke-Oven Carbonization." On behalf of the Institution, I have great pleasure in handing you, Mr. Chaney, this medal. While speaking of the very great work that has been done by the Birmingham Corporation, I do not want to neglect the individuals who have carried out the work; and I rather want to emphasize the special ability shown, not only by Dr. Davidson, but by Mr. Chaney, in connection with the papers that the Institution had last year. We congratulate the Birmingham Corporation on having your services, and trust that you will long be able to render very great and valuable assistance to the Institution in carrying out its great work.

Mr. W. CHANEY (Birmingham): Mr. President, ladies, and gentlemen, I have to thank you very much indeed for your kindness in awarding me this medal for my paper. I can assure you how much I appreciate this award, especially as I think it is more by fortune than anything else that I have received it. The subject on which I wrote was one that was somewhat new; and a good deal could be written about it. Therefore, as I have said, it was really more by fortune than by merit that I have succeeded in getting the medal. I thank you very much for the award; and I hope on some future occasion I may be allowed to lay before you further references to coke-oven carbonization, which I think is now only just in its infancy.

AN ADDITIONAL MEDAL.

The PRESIDENT: There is a further medal, which has been awarded to Mr. F. W. Goodenough for his paper on "Creating an Outdoor Staff." In handing this medal to our friend Mr. Goodenough, I do desire to say that the work represented by the paper for which this medal is awarded is as nothing compared with the debt we owe to him in connection with the work of distribution. The paper was a most excellent one. It is a classic in connection with the work; and Mr. Goodenough, in preparing the paper, has laid us under very great indebtedness to him. I have much pleasure in handing you this medal, Mr. Goodenough, as a mark of our appreciation of what you have done.

Mr. F. W. GOODENOUGH (London): Mr. President, ladies, and gentlemen, I very much appreciate the honour that the members of the Institution have conferred upon me in awarding me this medal; and I have to thank you, Sir, for the very kind words with which you have presented it. If the reading of the paper should be of service in forwarding the cause of improved education of the staff and men employed in the gas industry, I shall be more than rewarded for any labour that its preparation involved.

## President's Address.

The PRESIDENT then delivered his Inaugural Address, which was given in the "JOURNAL" last week, p. 763.

At its close,

Mr. H. WADE DEACON said: Gentlemen, without any previous notice, I have been asked to propose a vote of thanks to the President for having delivered this exceedingly able address. I have been very much interested in hearing what he has had to say to you. Though he has touched on a large number of different subjects, he has handled them all, as it appeared to me, in a reasonable and fair-minded way. I do not, of course, profess to be a gas engineer. That is beyond my aspirations. But I do understand something of the ordinary commercial affairs of a gas company; and it is in the ordinary working relations between the employer and the employed that I take an interest. Mr. Allen has referred to various operations that take place in the Liverpool and other gas-works; and it is a matter of great satisfaction to everyone to know that the relations between the employers and the employed in the Liverpool works are on such a good footing. I do not propose to touch upon the technical parts of Mr. Allen's address. As he points out, anyone who goes to the Linacre works will see some of the modern inventions in operation there; but as he has told you that the gas-works are nearly a hundred years old, of course, there must be some old plant visible. If you find some of the plant that you would like to criticize, I hope you will remember our age, and be kind to our infirmities. I have great pleasure in proposing that a hearty vote of thanks be given to the President for his most interesting and able address.

Mr. JOHN YOUNG (Hull): I have great pleasure in seconding the vote of thanks which has been so ably proposed by the Chairman of the Liverpool Gas Company, who has given you some idea of his appreciation of the address from the point of view of the commercial head of a large undertaking. I wish I had the time to give you some idea how it strikes a gas engineer. I am sure you will all have felt that Mr. Allen has called our attention in his able address to every important branch of the engineering department of a gas undertaking, not only the relations of the engineer to his directors, or his committee, as the case may be, in seeing that his works are kept up to date, and that every effort is made to produce gas at the lowest possible cost and of the best possible quality to suit the requirements of the present day, but also that the engineer should have the cordial and loyal assistance of all those who are subordinate to him, which can only be obtained by the kindness and good fellowship of the chief himself. I am sure we must all feel that Mr. Allen has secured the cordial co-operation of every one subordinate to him, from the lowest to the highest, and that to a great extent the splendid condition of the Liverpool Gas Company is due to his own personality, which has led to maintaining for so many years a feeling of friendship between the powers that be and those who have to do the actual work of producing the gas. Our time is so valuable that I will add no more, except that I am sure I am expressing the feelings of every gas engineer in seconding the vote of thanks to Mr. Allen for his address.

The motion having been received with acclamation,

The PRESIDENT, in reply, said: Though I may but briefly express my appreciation of the kind remarks made by Mr. Wade Deacon and Mr. Young, I am very sensible of their kindness, and I appreciate highly the manner in which you gentlemen have received this vote. I thank you very heartily.

## Annual Report.

[See "JOURNAL" for June 2, p. 637.]

The PRESIDENT: We have now come to a very important part of the conference proceedings, and that is the presentation of the Council's annual report for 1913-14, and the statement of accounts for the year ending Dec. 31, 1913. Copies of the report are in the hands of all of you; and I do not intend to take up much time in submitting it to you. But there is one thing in particular I want to call your attention to. You may remember last year Mr. Edward Harman brought forward a resolution calling upon the Council to deal with the question of providing a building for the Institution. This resolution was carried almost unanimously; and the matter was, therefore, considered most seriously by the Council at their next following meeting—and not only then, but the matter has been discussed on various occasions. The Council felt that it was quite impossible to take any active steps in this direction. It was not that they were unsympathetic with the idea of having a building to accommodate our offices, and to enable us to better carry on the work of the Institution; but the provision of the money necessary to erect the building was the important question. Considering that we were dealing with the exhibition that was held last year, and that the industry had been called upon to subscribe so much money for that, as well as the contributions to the British Commercial Gas Association, we thought that the time was not suitable for making a further appeal. We have, however, decided to recommend the Institution members to allocate the sum of £500 to a building fund out of the amount of money we have invested. This will be earmarked for the purpose. It may be said that it will be a nest-egg in connection with this work. It is possible that some wealthy gentleman, or gentlemen, may see his, or their, way to put £19,500 to the £500, and thus, at all events, give us a sum that we can do something with. I trust that the members present at the meeting will do something to show their appreciation of the way we have carried out their wishes, although we have now nothing very definite to place before the meeting. There is another matter that I want to mention,

and it is this: Sir Corbet Woodall has been in communication with our Secretary; and he states that he intends to offer a sum of money to provide for a travelling studentship in the Technical University Departments in our country, or a scholarship at one of the Continental Universities of £50 a year, to be awarded annually to a student of this Institution, if in the opinion of the adjudicators there is one who merits it. Of course, we must consult with Sir Corbet Woodall on the matter of the title; but it was suggested to the Council last night that it should be called the Corbet Woodall Scholarship. However, this will be a matter that can be dealt with later. I propose that we adopt the report of the Council and the statement of accounts. I wish to say that, although there is a great deal of matter contained in the report, it by no means represents the amount of work which has been done by the Council during the past year. It has been said that we are somewhat lacking in initiative. We are of opinion that we have started a great many things. In some cases very important matters, in the opinion of some, have been brought before Council meetings, merely to be laid aside; and I hope that you will realize that there has been a great deal more business done than the report indicates, and that you will appreciate the very painstaking labours of the gentlemen whom you appointed last year to assist on the report of the Council. I will not say anything more, as the luncheon hour is drawing near; and I hope we shall not be made to suffer the pangs of hunger, as we have done in former years, because some of our friends have had a great deal to say.

The Hon. Secretary (Mr. W. E. Price, of Hampton Wick): I have very much pleasure in seconding the adoption of the report and accounts. As the President has said, our time is getting short. Therefore I do not propose to detain you with any remarks.

Mr. E. A. Harman (Huddersfield): The President has referred to the establishment of a fund relating to the provision of a National Gas Institution building; and the report states that the time is inopportune for this. But the idea last year was that a fund should be established having for its object the erection of such an Institute; and the establishment of the fund that you, sir, have indicated is exactly on the lines that I believe the members desire. There should not be simply the allocation of a sum from the Institution's funds, but a fund should be established having for its ultimate object the erection of a suitable home for the Institution. I am very delighted that the Council have taken this view of the situation; and I hope it may go on to ultimate victory.

Mr. George Helps (Nuneaton): The more one criticizes the work of the Council, the more I think is one likely to appreciate it. It would not be wise for the Council to expect most of us in the body of the hall to approve of all that they do, or to find excuses for all that they leave undone; so I need make no apology for the few remarks that I shall venture to offer. In the first place, I should like to call attention to the awarding of the medals. I again express regret that it should be found necessary to award two medals to one man. This is no reflection on Dr. Davidson. I believe last year, or the year before, the same thing occurred. It is a great pity that the gold medal and the silver medal should be given to one and the same man, when there are so many men here without any medals at all. [Laughter.] Then there is still another point, Mr. President, and that is I think it is a pity that the papers that the Junior Associations give should not receive consideration when these medals are awarded. I regret that the Committee on Carbonization is to drop out. Most of us appreciated the work that this Committee did. We know in these days of transition how difficult it is to tabulate various results. I think if the Committee had taken us a little more into its confidence, and told us what the difficulties were, we should have learnt something more from the work which they most unquestionably have done. With regard to the standardization of pipes, this is a matter that is most interesting to me. I do not know anything of the meetings that have taken place with regard to cutting the threads for tubes; but I think the sooner they drop talking about threads the better, because threads will soon be things of the past. I was very glad to hear from the President that £500 has been allocated to a fund for the building of a National Institution. I should have thought that it might have occurred to the President to ask all the members present to put up a guinea, so as to make up another £500 before we leave the meeting.

The President: Ladies and gentlemen, it appears to me that the Council's report has gone off very well this year. You know it was suggested that if we put the President's Address before the discussion on the report, this would be the means of toning-down things considerably. Some of our friends come here with very keen minds; and after having had a good night, and a good breakfast, they are prepared for anything. Then when they have listened to the President's Address for half-an-hour, it rather takes the edge off their keenness. But it may be that you are more satisfied with the report this year. I am delighted to hear that Mr. Harman approves of what we have done. Mr. Helps always gives us something interesting; and his desire that the medals should go round is really very kind. But you all know that the "London" Medal is not given by the Institution; it is Mr. Jones's medal. We do the best we can with it; and if one man deserves two medals he gets them. With regard to your suggestion that each member should subscribe a guinea, the fund is open, Mr. Helps. It occurs to me that, after you have finished with Liverpool, you may not have many guineas to spare. I now formally put the resolution to the meeting, that the report and statement of accounts be adopted.

The resolution was unanimously agreed to.

## REFRACTORY MATERIALS COMMITTEE.

The report of the Refractory Materials Committee was then presented by Mr. F. J. Bywater (London). It was as follows:

### REPORT OF THE REFRACTORY MATERIALS COMMITTEE.

It will be remembered that the use of silica retorts in the United States of America was commended by Mr. Ernst Körting and Mr. R. M. Searle, the Vice-President of the Rochester Railway and Light Company, New York, when the Committee's report was presented at the last Institution meeting; and inquiries have therefore been made by the Committee for the purpose of ascertaining the views of engineers in America who have used them. Through the kindness of Mr. Herman Russell, of the Rochester Railway and Light Company, the opinions and experience of several engineers and manufacturers of these retorts have been obtained. The inquiry was made in the form of a number of questions; and a list of these, with a synopsis of the replies, is given below.

It may here be mentioned that the American Gas Institute have recently appointed a Refractory Materials Committee, of which Mr. Herman Russell is Chairman; and your Committee are pleased to be able to report that they have entered into communication with the American Committee, and an exchange of reports and information relating to their work has been arranged, which it is felt will be of very great mutual assistance, as the purpose of the two Committees is identical.

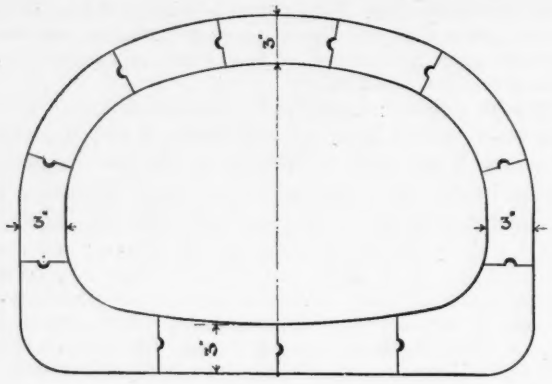
#### Silica Retorts.

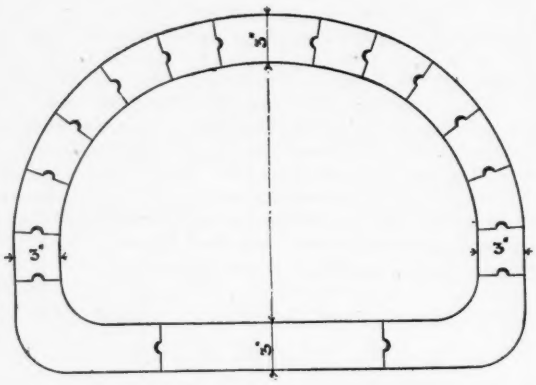
The material of which these retorts are made contains about 95 per cent. of silica, and is believed to be identical with the ganister quartz which is found extensively in South Yorkshire, Wales, and other parts of Great Britain. The quartz rock is crushed, and usually has a binding medium of about 2 per cent. of milk of lime. The manufacture is very carefully conducted, and the material has an excellent appearance, being mechanically strong, and well made.

The following are the questions addressed to Mr. Herman Russell, and the replies:

1.—*Is silica material used for whole retorts, or is it made into segmental tiles for built-up retorts?*

Although "whole," or moulded, retorts are now being tried in short lengths (about 18 inches long) for vertical settings, all the experience so far obtainable relates to segmental retorts built up of tiles, or a combination of bricks and tiles. The cross section sketches, p. 900, indicate the designs generally adopted.




2.—*Is there any expansion in the length of the retort when heated up? If so, how much, and how is this allowed for?*

Expansion takes place from $\frac{1}{8}$ to $\frac{3}{16}$ inch per lineal foot in the length and periphery of the retorts; and allowance must be made for this to be taken up when the heats are raised.

One method for overcoming the expansion is to make the joints with thick paper or straw board, which burns-out and forms a thin carbon joint.

Another method which has been found very efficacious is to use a cement made of mild aluminous clay, which will shrink when the retort-settings are put to work.

3.—*Does the material crack when first lighted up, or when in use, by reason of the cold air rushing into the retort when the lid is opened?*

The general experience is that well-made silica retorts do not crack from these causes; and this is probably greatly assisted by the fact that they are made of segmental tiles, and also by the frequent practice of making the mouthpiece end of the retort of solid moulded fire-clay, which sometimes extends as far into the settings as the first cross wall. The cold air which enters the retort when the lid is opened first impinges on this fire-clay piece (which does not crack), and by the time it reaches the silica material the temperature of the air has been considerably raised, and it has no harmful effect.

4.—*Are silica retorts used in connection with stoking machinery? If so, what is the type?* [*Please state if the retort is discharged by means of a pusher.*]

Silica retorts have been used in settings worked with De Brouwer, Fiddes-Aldridge, Ritter Conley (West's), and Bredel hydraulic discharging machines.

5.—*If stoking machinery is employed, do the retorts give entirely satisfactory results?*

No difficulty is said to be experienced in this respect; and some engineers state that less carbon appears to be formed on the inside of the silica retort, while the surface becomes glazed over, thereby facilitating discharging by pushers.

No doubt, also, the length of fire-clay retort at the mouthpiece end takes-up the extra wear and tear usually experienced from stoking machinery at these points.

6.—*What is the maximum life which has been obtained without patching a silica retort? Please state if stoking machinery was used.*

The life of silica retorts is said to be about $3\frac{1}{2}$ to 4 years when used with stoking machinery, and to be considerably longer than that of the clay retorts made in the United States.

7.—*What is the saving in fuel, in a good regenerative setting, when employing silica retorts, as compared with fire-clay retorts?*

There is a consensus of opinion that the silica retorts have a greater heat conductivity than those made of clay; and this is said to show itself in a lesser fuel account, although the greatest advantage in this respect is found in the increased carbonizing capacity of the retorts, owing to the possibility of burning-off the charge much more quickly.

It will be observed that the experiences reported so far are favourable, and no doubt some engineers on this side will decide to experiment with silica retorts at an early date. It is suggested, however, that these trials should not be of too extensive a nature at first, as there are several points in connection with the use of silica material for retorts which require care—such as the arrangements made for taking-up expansion. The material should also be thoroughly well made, free from cavities, possessed of good physical strength, and not loose and friable, as is often the case with highly silicious material.

The use of silica retorts has been to a considerable extent developed by several large companies in the United States of America; and as it may not be possible for engineers in this country to avail themselves of the experience of these firms, they will have to rely on making their own arrangements with manufacturers here for trial retorts. It should be mentioned, however, that "No. 1 Grade Silica" material in the third section of the standard specification covers bricks and blocks made from ganister quartz; and generally the material should be in accordance with the conditions and tests specified therein.

### Testing Refractory Materials under Load.

The importance of testing samples of fire-brick and retort material in such a manner as to approach as nearly as possible working conditions, is obvious; and at the time of the preparation of the standard specifications the Joint Committee of engineers and manufacturers gave the matter very careful consideration. Unfortunately, very little definite technical information on this subject was available at the time, and the refractory tests specified are therefore carried out with the samples lying freely in a gas or electric furnace, as has hitherto been the practice in clay-testing laboratories.

Recently, however, the importance of the load factor on the fusibility of refractory materials has been raised; and the Committee therefore, in collaboration with the Retort and Fire-Brick Section of the Society of British Gas Industries arranged for an investigation in this subject to be carried out under the supervision of Dr. J. W. Mellor. Samples of the clays employed in the manufacture of fire-brick and retort material were obtained from Stourbridge, Yorkshire, Newcastle, and Scotland, and tested in the usual way, and also when carrying various loads. The results are tabulated on p. 901.

The minimum crushing strength of fire-bricks allowed in the specification is 1800 lbs. per square inch; and the above results, which show a decrease in refractoriness of 12 per cent., or 13 per cent. when the test sample is subjected to a load of 54 lbs. per square inch while it is being heated up, are therefore very surprising. Whether these results will be entirely borne out in practice, it is impossible to say without further investigation; but it is improbable that the melting point of fire-bricks is lowered to such a considerable extent in retort-settings. The matter is one of very great importance to engineers and manufacturers; and it is felt it would be unwise to attempt any alteration of the specification without further information. It may be pointed out, however, that the great majority of the best retort and fire-brick material available in this country generally falls just within the limits of the refractory tests specified by the Committee; so that the question of increasing their severity in this respect will have to be very carefully considered. The investigation will, however, probably throw valuable light on the behaviour of refractory material when in use, and it need

GROUP I.

| Experimental Number. | Normal Melting Point. | Melting Point under Pressure of 54 lbs. per Square Inch. | Melting Point under Pressure of 72 lbs. per Square Inch. |
|---|---|---|---|
| | Degrees Cent. | | |
| 1 | 1650 | 1435 | 1380 |
| 2 | 1630 | 1410 | 1350 |
| 7 | 1580 | 1380 | 1350 |
| 12 | 1690 | 1435 | 1410 |

GROUP II.

| Experimental Number. | Normal Melting Point. | Melting Point under Pressure of 84 lbs. per Square Inch. | Melting Point under Pressure of 112 lbs. per Square Inch. |
|---|---|---|---|
| | Degrees Cent. | | |
| 3 | 1690 | 1460 | 1380 |
| 4 | 1710 | 1500 | 1435 |
| 5 | 1670 | 1460 | 1380 |
| 9 | 1750 | 1580 | 1580 |
| 10 | 1690 | 1500 | 1460 |
| 11 | 1670 | 1460 | 1380 |
| 16 | 1730 | 1460 | 1110 |
| 17 | 1770 | 1520 | 1410 |

N.B.—No. 17 is a typical china clay of first-class quality, and was used for the purpose of comparison. It is interesting to note that some of the clays very nearly equal it in refractoriness.

not be inferred from results already obtained that the testing temperature will have to be raised for normal working. It is therefore proposed by the Committee to regard these figures as a preliminary exploration of the subject, and to continue the investigation in the ensuing year in collaboration with the Committee representing the manufacturers.

The Committee hoped to be able to report also this year the result of investigations into the effect of porosity on heat conductivity, and also of reducing atmospheres on the fusibility of fire-brick and retort material. But owing to the delay in obtaining suitable apparatus in his laboratories, Dr. Mellor found it impossible to complete the experiments in time for this meeting.

### COLLABORATION WITH OTHER LABORATORIES.

The Committee have for some time past received very valuable assistance from the Staffordshire County Pottery Laboratory, which is directed by Dr. J. W. Mellor; and they are now endeavouring to arrange for collaboration and exchange of information and tests with the National Physical Laboratory and Professor Cobb's laboratories at Leeds University, which it is confidently hoped will considerably strengthen the work of the Committee.

### WORKING OF THE STANDARD SPECIFICATIONS.

No complaints have been heard of in respect of material supplied in accordance with sections 2 and 3 of the standard specifications [Fire-Clay Bricks, Blocks, Tiles, &c. and Silica Material]; but, although none has been expressed to the Committee, dissatisfaction is still sometimes found with regard to certain retorts made to conform to Section 1. No trouble appears to be experienced in normal working in the matter of refractoriness, and the complaints mostly arise from the fact that these retorts are covered with surface cracks, being loose in texture, and contain cavities and fissures more or less extensive. Such defects are serious ones, and ought to be remedied at once. It cannot be too strongly urged that porosity should not be obtained by cavities of this nature, and that, while density must be avoided, retorts should possess sufficient homogeneity to give good surfaces and physical strength.

Another matter which has been under the serious notice of the Committee is the destructive influence on retort-settings of dust mechanically carried over with the producer gases. This, owing to the large quantities of oxide of iron and other fluxes it contains, results in the formation of fusible slags, and so involves the destruction of material which, in the absence of this dust, would resist the highest temperatures required. The attention of all engineers is therefore earnestly directed to the necessity of reducing this injurious dust to a minimum, if satisfactory results are to be obtained with good material.

The Committee also again wish to appeal to engineers to bring to their notice the results of their experiences and any difficulties they may encounter in their regular working with refractory materials, whether favourable or not, as it is only by the co-operation of all concerned that good progress can be made.

*June* 10, 1914. (Signed) H. G. COLMAN, *Chairman.*

Mr. BYWATER, moving the adoption of the report, said: Mr. President and gentlemen,—I have great pleasure in presenting to the Institution the Refractory Materials Committee's report; and, in doing so, I should like, with your permission, to refer to one or two of the points in it. First of all, I would like to say how very pleased the Committee are to notice that the American Gas Institute have appointed a similar Committee to make their own investigations on refractory materials. They have followed the plan that we adopted here, of taking the manufacturers into their councils, and help to prepare their specifications—probably not on the lines that we have followed, but they will take their own independent line. I am very glad to be able to say that we have already established what I think are very cordial relations with this Committee; and we have agreed upon an interchange of information, tests, and reports which I think will be of great benefit, to us at any rate, and we hope also to our friends on the other side. I should like to say, shortly, that the information we have obtained from our friends has been most satisfactory. [Mr. Bywater exhibited a brick made from material containing 95 per cent. of silica, as described in the report, and said it would be seen that it made an excellent tile. He went on to epitomize the answers given by Mr. Herman Russell to the questions addressed to him.] Some years ago, Mr. Morrison introduced, not quite the same material, but a very similar ganister material, for use in segmental retort tiles in Sheffield. I know that he is very pleased indeed with these retorts, and that they give an excellent life. The difference between the material that Mr. Morrison uses and the brick I have exhibited is that, though they are both ganister, the brick is more highly silicious—containing 95 per cent. of silica, to Mr. Morrison's 85 per cent. [Mr. Bywater then went on to summarize the report with regard to the depreciation of refractoriness of fire-brick material when under load, and said that the results of tests made in this direction had very much surprised the Committee.] I hope the members will remember that we are a technical Committee, and that we are wanting to hear from them all their experience in connection with retort construction. There are vast quantities of excellent clay in this country that only needs careful handling to produce excellent results. A large quantity of fire-brick clay is annually exported from this country, to be re-imported in the form of retorts. It is up to our manufacturers to do their utmost to stop this. It is only fair to say that they are taking a keen and active interest in this matter; and it is to be hoped that satisfactory results will be obtained later on. I beg formally to move the adoption of the report.

Mr. A. E. BROADBERRY (Tottenham): I beg to second the adoption of the report.

Mr. J. W. MORRISON (Sheffield): Mr. President and gentlemen, since I have been at Sheffield it has been my rule, which I am still following, to make the upper portion of all the retorts we have there, which are all built of brick and tile, entirely of silica clays. We have not gone quite so far as Mr. Bywater has recommended—to use clay containing 95 per cent. of silica—but we have been quite content with those obtained from the East Riding of York containing 85 per cent. We have taken retorts out that have been in use between 3000 and 4000 working days, with the original material in the upper portion of the retort practically as good as the day it was put in. Of course, the upper part of the retort gets no wear and tear from the coal or the mechanism employed for putting the charge into the retort. We tried the effect of putting a silica material in what may be called the springer tiles and the bottom tiles. In the old days, owing to the greater amount of friction on this portion of the retort, we found that it was not quite suitable, and also owing to the amount of sulphur from the tar, and the different conditions to which the bottom would be exposed in the front of the retort. Therefore we tried to get the best materials from Stourbridge to put in this position. Since we have gone on to heavier charges, we fill the retort at the mouthpiece; and I have now settings put in entirely of silica. We tried some of 95 per cent.; but, although it was good for standing the fire, it was rather soft. I was somewhat surprised to hear it stated that there was from $\frac{1}{8}$ to $\frac{3}{16}$ inch expansion per foot of retort when built of this material. You would certainly not get it from a retort built of 85 per cent. of silica. I am very glad that the Refractory Materials Committee are able to endorse what I have found

to be a practical success; and I congratulate the Committee on putting such a report before the Institution.

Mr. W. Chaney (Birmingham): Mr. President and gentlemen, there is one point that rather interests me, and which perhaps the Refractory Materials Committee would not take exception to my referring to, and that is, that, though we are aiming at very high refractory materials, there is a point which I think is somewhat neglected—namely, that in all coals we are dealing with in carbonization there is a constantly varying quantity of salt, and no matter how highly refractory the material may be, it seems that we should aim to get a substance which will withstand the action of the salt. I understand that in America something has been done in this direction, and that they have been able to find a material which is not only highly refractory, but sufficiently suitable to withstand the effects of the salt. It is a lime-bound brick, instead of the usual clay bound; and 10 tons of coal are capable of being carbonized within 16 hours.

Mr. John West (Southport): I gather from the report that a large proportion of the material has been sent from England, and the retorts have been manufactured abroad. This indicates, to my mind, that we have the suitable material in England, and only want the brains to put it together properly. I think Mr. Bywater will back me up in this statement. I have tested all the fire-bricks that are made on the Continent, and everywhere else; and I can assure you that we have material in England as good as anywhere in Europe. It is the putting of the materials together that is the thing; and it is unneccessary for us, if we can find the brains in England, to go abroad for our retorts.

Mr. H. Kendrick (Stretford): I should like to call attention to the fact that all silica clays to be found in the British Isles do not expand to the same extent. There is one clay in particular which expands to an even greater extent than the figure given by Mr. Bywater; but there are other clays of the same character, containing up to 95 per cent. of silica, which have a very slight expansion indeed. I need not mention any names.

The President: If there are no further remarks to be made on the report, I will ask Mr. Bywater to reply to the points that have been raised.

Mr. Bywater: With regard to the question raised by Mr. Morrison, I should point out that it was not a recommendation of the Committee. It is an epitome of the information we have obtained from America. We put it before the members to choose for themselves; but we do think that it is an experiment that the members might make. With regard to 85 per cent. silica, it is exactly the same measure of clay coming from the same seams; but it is more highly silicious. I was glad to hear Mr. Chaney raise a point with regard to the salt. This is a very important matter, because I have seen retorts fused on the inside which were quite good on the outside, where they were exposed to the producer gas. This is a point on which the members might very well make some investigations themselves, and report the results to the Committee. Of course, this is a very difficult thing for the members to take up, because of the very wide range of clays that are used in the industry; but if they have any information to impart on these matters, the Committee would be glad to hear from them. I should like here to refer to a letter I have received from Mr. Harold Woodall, in which he says that, as the result of the Committee's work, he has found himself able to obtain infinitely better material than he could formerly. During the last three years, he says, he has tested 2500 samples of fire-brick material in connection with the system of carbonization with which his and Mr. Duckham's names are associated; and he finds, as the result of the work of the Committee, that, whereas in 1911 and 1912 the average shrinkage of the material he used for his retorts was 1·5 per cent., he is now able to obtain material with an average shrinkage of 2·5 per cent. Two years ago, he had to pay 10 per cent. premium in order to obtain material with less shrinkage than 1 per cent., but can now secure material which is quite satisfactory to him without paying any such sum. I thought this was rather interesting, as showing the practical result of the working of the Committee.

The report was unanimously adopted.

### Message to Sir Corbet Woodall.

The President: It is your wish, I am sure, gentlemen, to send a message to Sir Corbet Woodall, with reference to his very handsome proposed gift. Therefore, it has been suggested that the following should be forwarded: "The members of the Institution of Gas Engineers desire to sincerely thank Sir Corbet Woodall for his generous offer of a scholarship, and suggest for his consideration that it should be called the 'Corbet-Woodall Scholarship of the Institution of Gas Engineers.'"

## REPORT OF THE VENTILATION RESEARCH COMMITTEE.

The following is the report of the Ventilation Research Committee:

### FIRST REPORT OF THE JOINT COMMITTEE ON VENTILATION RESEARCH OF THE INSTITUTION OF GAS ENGINEERS AND THE UNIVERSITY OF LEEDS.

#### Introduction.

In 1913, the Council of the Institution considered the advisability of promoting an investigation of the ventilation problem, and a Committee was appointed, representing the Institution and the University of Leeds, to deliberate upon the subject. After full discussion, the Committee reported unanimously in favour of the project; and they were thereupon authorized by the Council to take the necessary steps to carry their recommendation into effect.

The Committee made their recommendation, and have entered upon their work with a full sense of the difficulties involved. Ventilation has been the subject of innumerable investigations, resulting in the accumulation of much knowledge. Notwithstanding the vital importance of the question, however, from the standpoint of public health, and the constant and urgent demand for reliable information, it must be confessed that the whole subject is in a fluid state, and that great differences of opinion and practice prevail. Data which could serve as a safe basis for dealing in a scientific way with the problems of ventilation as they arise in their endless variations are largely wanting.

This unsatisfactory state of things arises no doubt in the main from the inherent difficulties of the subject. The extreme mobility of air, its susceptibility to slight changes of temperature and pressure, the difficulties of discerning, tracing, and measuring currents of air, are too well known to need emphasizing; and the great differences in the conditions under which the problem of ventilation has to be faced in different cases enable us to understand that no series of simple prescriptions of universal applicability can be evolved.

Notwithstanding their full appreciation of these difficulties, the Committee felt that the importance of the subject must compel them to proceed if they could see any field for inquiry, however limited, that appeared to give reasonable promise of affording useful knowledge. After consideration, they decided that it would be well worth while to try and gain some definite information on ventilation in spaces as nearly as possible free from the accidental and capricious influences of what may be described as external factors. The preliminary work in connection with this inquiry is contained in the following report.

The Committee believe that they have been very fortunate in securing the services of Mr. W. Harrison, M.Sc., to carry out the work under the direction of Professor Cobb; and they desire to record their appreciation of the skill and industry which he has shown in the initial work.

#### The Work of the Committee.

The Committee met for the first time on July 31, 1913, at the University of Leeds, and after discussion decided that a research on the ventilation of rooms by gas was advisable. Grants requested from the Institution were made, and a research chemist (Mr. W. Harrison, M.Sc.) was appointed to carry out work for the Committee under the supervision of Professor Cobb. The Committee have met four times.

It is intended to eventually have experiments made on ventilation as it occurs in actual buildings; but it was felt that in order to secure results which might be of permanent value, though perhaps not immediately applicable without modification to actual practice, it would be necessary to carry out a series of experiments under standard conditions. For this purpose it was decided to build a special room, so

constructed that outside influences should be counteracted and the necessary standard conditions established.

The outside influences are:

1.—Air currents, winds, and similar disturbances in the atmosphere.
2.—Variations and large differences in temperature of the air inside and just outside the room.
3.—Presence of warm bodies (human beings, &c.), and heat-absorbing substances within the room.

The standard conditions to be established are:

1.—Air entering the room must have as nearly as possible a constant temperature and chemical composition.
2.—Air must enter and leave the room steadily, and, as far as possible, only through known openings.

After consideration, the main features of a construction which would satisfy these requirements were decided upon, thus:

The experimental room to be made of non-conducting material, as nearly air-tight as possible, and enclosed in another room with sufficient space between to allow observations to be made; windows to be provided in the walls of the inner room for this purpose.

The outer room to be divided horizontally into two equal parts, to act as separate reservoirs for inlet and outlet air; so that the fresh air entering the inner room should not vary in composition by admixture with the vitiated air leaving it.

The openings between the outer room and the outside atmosphere to offer as much resistance as possible to disturbances of the air within the outer room by winds and air-currents in the outside atmosphere. For this purpose it was decided to make these openings of perforated material in the form of sieves, single or multiple, placed symmetrically above and below the dividing partition.

In order to minimize variations in the temperature of the air in the outer room by heat communicated by the sun, and to make the building more resistent to atmospheric influences, it was decided to construct the outer and inner rooms of the same non-conducting material.

Drawings of these buildings were prepared, and the erection was placed in the hands of Bell's Asbestos Company. An explanatory drawing, fig. 1, is appended.

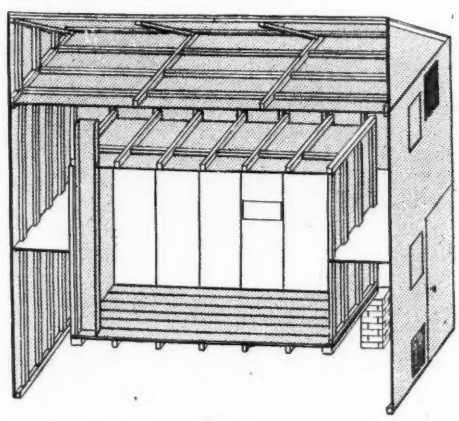


Fig. 1.

While these matters were being settled, preliminary experimental work was carried out, one part of which had relation to the alleged liability of combustion products from gas-fires to escape under the canopy. For this purpose tests were made on four gas-fires, with and without the attachment of a short flue pipe 18 inches high and 6 inches in diameter.

The results, which are given in more detail below, seemed to show that, after the fires had been burning for some time (so that standard conditions had been attained), there was in most cases a very small, but determinable, escape of combustion products from under the canopy. Immediately after lighting the fire, this escape was more noticeable; but in every case the addition of the flue-pipe practically eliminated all escape. The usefulness of a short length of flue-pipe was thus indicated. The differences in the escape of products at the start—*i.e.*, in the first minute—with the various fires showed that the design of the fire itself was of great importance in this connection.

For the above and other purposes it was essential to get a satisfactory means for the estimation of carbon dioxide. The method used previously by the Gas-Heating Research Committee was first used, and eventually modified so as to make it more convenient. The method of collecting samples for analysis, which consisted in exhausting a large bottle and allowing it to fill with the air, was retained. The main modification consisted in carrying out all the necessary titrations of barium hydrate in an atmosphere of air freed from carbon dioxide.

In order to obtain results without depending upon the comparatively slow process of collecting samples of air for analysis by the method just mentioned, there was obviously considerable advantage to be gained by passing the gas continuously through barium hydrate solution and estimating the barium hydrate electrically, since the necessary measurements of electrical resistance could quite easily be made at frequent intervals; the decrease in conductivity representing the barium carbonate formed, and therefore the carbon dioxide absorbed. This method (further details of which are given below) was worked out satisfactorily for flue-gas determinations, but as yet has not been adapted successfully for the determination of carbon dioxide in air, where the quantities present are so much smaller.

It was also advisable for many purposes to be able to measure low pressures and low velocities of air; and experiments were made in order to ascertain what methods were available and what accuracy could be obtained. The details are appended.

It was considered likely that useful results might be forthcoming from the direct comparison of the air-drawing power of gas-burners placed under determined and controllable conditions. For this purpose an apparatus, based on the principle used by Shaw in his experiments on ventilation [air-currents and the laws of ventilation] was designed, in which the burners were so placed that their drawing powers were brought into opposition; a detector being provided, in the form of a delicately poised mica vane, to ascertain when a balance had been obtained.

The results so far obtained with this apparatus indicate that, as a laboratory measuring instrument, it is capable of yielding accurate and quantitative results; and it promises to be of considerable service for the purposes of this investigation.

### Details of Experimental Work carried out for the Committee by the Research Chemist (Mr. William Harrison, M.Sc.), under the Supervision of the Livesey Professor, Mr. J. W. Cobb.

Pending the construction of the experimental room, preliminary experiments were made on the ventilating power of an old type gas-fire with a circular flue vent $2\frac{3}{4}$ inches in diameter. These were carried out in the old experimental room used by the Gas-Heating Research Committee, and described in their report. In order to obtain samples of constant composition, a perforated sampling pipe was fixed in the flue about 3 feet above the flue vent of the gas-fire.

The quantity of air entering the room by the 3-inch opening, as determined by an anemometer, was about half that leaving by the flue, which was ascertained by chemical analysis. When the 3-inch opening was closed, about half the quantity of air passed up the flue.

The experiments, although qualitative, showed that the amount of air drawn up a flue by a gas-fire depends on the resistance offered to the entrance of air into the room. This is a point which is fairly obvious, but often neglected as of no importance. It proves the necessity for having standard conditions for testing the ventilating power of gas-fires. The resistance offered to the exit of air would also influence the results.

A similar set of experiments carried out on a windy day, under otherwise identical conditions, gave different and variable results; showing how necessary it is to counteract the influence of external air currents as far as possible, to obtain very satisfactory results either when testing gas-fires experimentally or in actual use.

#### Experiments with Gas-Fires.

Tests were made with four gas-fires in order to determine the amount of products escaping in front of the canopy, and also the quantity of air passing through the flue vent when

| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gas-Fire No. | Dimensions of Flue. Inches. | Area of Flue. Square Inches. | Distance B. Inches. | Distance C. Inches. | Distance D. Inches. | Gas Consumption. Cubic Feet per Hour. | $CO_2$ Added to Canopy Gas at Start. Parts per 10,000. | $CO_2$ Added to Canopy Gas when Running. Parts per 10,000. | $CO_2$ in Flue Gases Per Cent. | Approximate Volume of Gases Passing up Flue per Hour. | Approximate Volume of Gases Passing up Flue per Cubic Foot of Gas Burnt. |
| 1 | 12·6 by 2·4 | 30·0 | 4 | 3⅜ | 8 | 32·5 | 2·4 | 0·02 | 2·44 | 670 | 20·5 |
| | | | | | | 32·6 | 2·2 | 0·35 | 2·24 | 730 | 22·5 |
| 1a | .. | .. | .. | .. | .. | 32·4 | 0·5 | 0·3 | 0 83 | 1950 | 60·0 |
| 2 | 9·0 by 2·3 | 21·0 | 1½ | 4½ | 7½ | 24·5 | 5·4 | 3·6 | 1·67 | 730 | 30·0 |
| | | | | | | 28 4 | 9·1 | 3·1 | 1·70 | 830 | 29·0 |
| 3 | 10 by 1·6 | 16·0 | 3½ | 3½ | 5½ | 29·5 | 3·5 | 4·1 | 1·66 | 890 | 29·5 |
| | | | | | | 29·5 | 3·4 | 4·2 | 1·63 | 880 | 30·5 |
| 4 | 9 by 1·3 | 11·5 | 1¾ | 1¾ | 5¼ | 31·3 | 20·5 | 7·3 | 2·76 | 580 | 16·5 |
| | | | | | 4½ | 34·3 | 28·0 | 9·0 | .. | .. | .. |
| 4a | .. | .. | .. | .. | .. | 34·8 | 0·3 | 0 2 | 1·27 | 1370 | 39·5 |

NOTE.—a With flue-pipe attached.
Columns 4, 5, and 6 see Diagram III.
Column 8. "At start" signifies within the first minute after lighting the fire.
Columns 11 and 12. Volumes in cubic feet calculated to normal temperature and pressure.

no flue pipe was used, and again when an 18-inch length of 6-inch diameter flue pipe was attached by adaptors.

The amount of combustion products passing in front of the canopy was determined immediately after the fire was lighted, and again when it had been burning for some time. For this purpose a flexible lead hood (fig. 2) was used which could be fitted to any of the gas-fires. The hood is quite open at the top and bottom so as not to interfere with the air-currents which are ordinarily set up when the fire is burning. A perforated brass pipe passes along the whole length of the hood for sampling the air within it. The hood is so made that it can be divided into sections when required in order that determinations of the escape of combustion products from various points along the lower edge of the canopy can be made. A bent perforated pipe was used for taking the samples for analysis, from which the quantity of air passing through the vent was calculated.

### DETERMINATION OF CARBON DIOXIDE.

The method used was Letts and Blake's modification of the Pettenkoffer method, in which a large sample of air was collected in a bottle coated inside with paraffin wax, and shaken up with a known volume of standard baryta solution. The excess of baryta was titrated with standard acid in an evacuated flask. The use of the evacuated flask was rather inconvenient, and was discarded. The titration was afterwards carried out in an atmosphere of air freed from carbon dioxide.

The apparatus used is shown in fig. 4. A is an ordinary vacuum pump worked by water pressure. In ordinary use this pump draws air in at B and out at C. The lower end C in connected to a bottle D, and delivers the air and water into it. The water and some air pass out at the bottom through the tube T into the sink, while air only passes out at the top through the tube E into two towers—the first one filled with wet caustic potash, the second one with soda lime. In this way a continuous supply of air free from carbon dioxide is obtained, and may be got under pressure by adjusting the clip P so as to reduce the amount of air passing out by the tube T.

The air for analysis is collected in a large bottle, which is evacuated and allowed to fill with the gases. A known volume of standard baryta solution is forced in by carbon dioxide free air and, after shaking for some time, is transferred to the titrating vessel F, the bottle washed out, and the washings added to the solution. During this time carbon dioxide free air is passed continually through F, entering by the tube M and leaving by N. The excess of baryta is titrated by standard hydrochloric acid from a burette the tip of which passes into the titrating vessel F. For the analysis of flue gases a smaller sampling bottle is used, and the titration carried out in the sampling bottle itself, in a similar manner to the above.

The method gives satisfaction; but the collecting of a large sample of gas by evacuating a large bottle and allowing it to fill is rather a slow process. For this reason, attempts were made to absorb the carbon dioxide from the air directly by passing it through baryta solution. In order to determine the amount of baryta remaining in the solution without the necessity for removing it from the absorption vessel, an electrical method was devised, in which the electrical resistance of the solution was measured by the ordinary Wheatstone's bridge method before and after the absorption of carbon dioxide.

In order to ascertain the accuracy of the electrical method, an absorption apparatus was made with two bulbs, as shown in fig. 5. The connecting tube T contains two platinized platinum electrodes. For use, a sufficient quantity of baryta solution is run in to fill the bulb A, the tube T, and the limb B up to the mark C, and the apparatus turned over (to the left in the diagram) so that the liquid runs into, and fills, the limb B. For collecting samples for analysis the end N is connected to the source of supply of gas, and the taps P opened until the solution rises in the bulb to the mark *d*, and is then closed.

After shaking for some time, the electrodes are connected to the Wheatstone's bridge, and the electrical resistance determined; care being taken to keep the temperature constant. The difference between this and the resistance before shaking with gas gives the amount of baryta used up, and from it the quantity of carbon dioxide absorbed. Three determinations, with a gas containing 3·05 per cent. of $CO_2$, as ascertained by chemical analysis, gave 3·03 per cent., 3·08 per cent., and 3·05 per cent. The method is therefore accurate for the analysis of flue gases; but as the bulb of B only holds 89 cc., the apparatus is not suitable for analyses of ordinary air.

For the purpose of absorbing the carbon dioxide directly from the air, an apparatus was made in which the air passed three times through the same baryta solution contained in a vessel fitted with platinum electrodes. This apparatus failed to extract all the carbon dioxide from the air. For

Fig. 2.

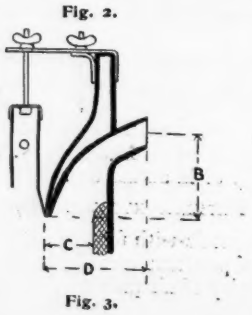



Fig. 3.

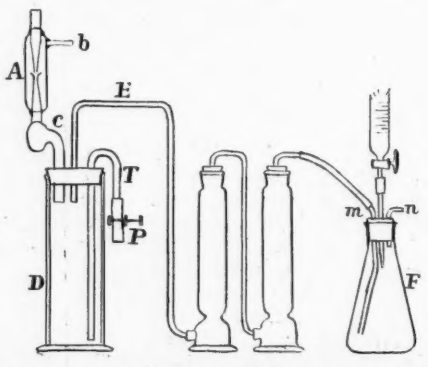



Fig. 4.

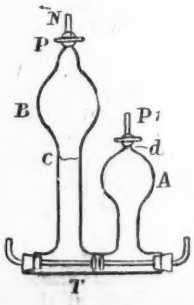



Fig. 5.

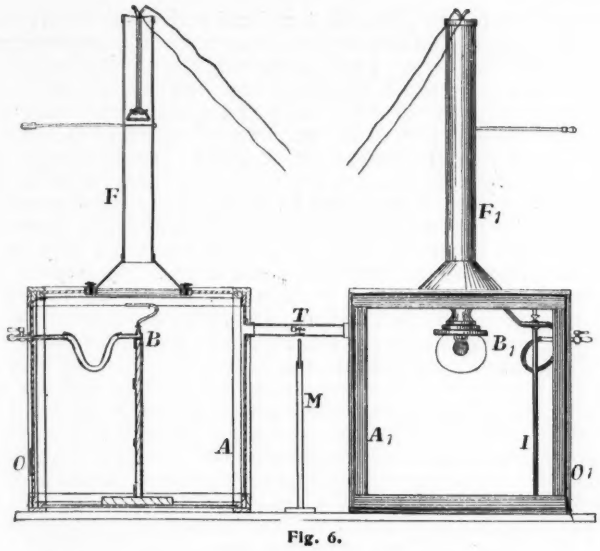



Fig. 6.

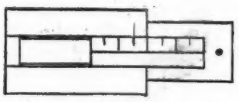


Fig. 7.

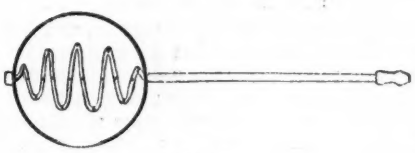


Fig. 8.

Fig. 9.

this reason a longer and narrower apparatus was made; but this also failed in its purpose. The problem of determining carbon dioxide in ordinary air by this method is therefore not yet satisfactorily solved; but some further work is being carried out upon it.

### Determination of Small Differences in Air Pressure.

The first experiments were made with an existing gauge which had been constructed on a recognized principle to enable small pressure differences to be measured. The apparatus consisted of two large bulbs connected by a narrow tube and containing immiscible liquids of nearly the same specific gravity. When there is a slight alteration in the level of the liquids in the two bulbs, the liquid flows along the narrow tube and alters the position of the line of demarcation between the liquids. With aniline and water, this separating line was not always clear, and did not come to rest in the same place after pressure had been removed from one or other bulb. According to Professor Thompson, with paraffin and aqueous alcohol much better results could be obtained; but when the apparatus was modified, to make it more sensitive (the two bulbs being connected by a long narrow tube placed horizontally), the line of demarcation fluctuated in position, probably owing to changes in temperature. As a further modification, the whole apparatus was filled with water, and a globule of benzene introduced into the narrow tube to act as an indicator of the flow of water caused by a difference in level between the liquids in the two bulbs.

The apparatus appeared to give good results when pressure was always applied at the same bulb; the globule of benzene moving along the tube for a distance equal to 200 times the difference in level between the liquids in the two bulbs. However, when pressure had been applied at the other side and removed, the globule did not return to the same position as before; being about 8 cm. from its previous position.

It appears from these results that an apparatus of a type similar to those mentioned would be suitable for certain purposes, but would have to be considerably modified to be used for absolute determination of very small differences in pressure.

### Direct Comparison of the Drawing Power of Gas Burners.

It is known that the drawing power of a burner must depend on the resistance offered to the entry of air into the room or space from which the burner is extracting air. An apparatus was therefore designed in which this resistance was controllable.

The apparatus (fig. 6) consists of two similar air-tight boxes A $A_1$, fitted with flues F $F_1$ of the same size, and adjustable openings O $O_1$ (shown in detail in fig. 7) for the entry of air into the apparatus. Under the flues the burners B $B_1$ are placed, and when burning draw air through the openings O $O_1$, and up the flues. The boxes are connected by a glass tube T, containing a delicately balanced mica vane attached to a small magnet as a detector of air currents. A magnet M under the detector serves to bring it to a zero position when there is no current along the tube.

When in use each burner creates a certain head; and if the openings for the entry of air into the boxes are equal, the burner with the stronger drawing power draws air from the other box along the connecting tube T. By adjusting the openings a condition can be established in which no air flows along the connecting tube. In this condition the heads produced in the flues by the two gas-burners are directly proportional to the squares of the areas of opening into the boxes in which they are placed, providing the flues have the same pneumatic resistance. A comparison between the drawing power of two burners can be made in this way, or of any one burner against the standard.

A bent perforated pipe (fig. 8) is used for sampling the gases passing up the flue, and a platinum resistance thermometer (fig. 9) for measuring their average temperature.

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The President: I am very sorry to inform you, gentlemen, that Professor Smithells is unable to be with us this morning, owing to the unexpected illness of his wife. In his absence, Mr. Bond will propose the resolution for the adoption of the report.

Mr. John Bond (Southport): Mr. President and gentlemen, I sincerely regret that Professor Smithells is not here to-day to present his report on the important subject of ventilation. I think the Institution of Gas Engineers are particularly fortunate in getting their research work done at such an important institution as the Leeds University, and by such an able man as Mr. Harrison, who is acting under the guidance of Professor Cobb. The subject of ventilation will be briefly gone into by Mr. Harrison; and as this is an important matter, I should like to say that we have made use of the method of substituting gas for electricity for ventilating some of our buildings in Southport which were looked upon as death-traps. By this plan, we are able to get much better ventilation of churches and large buildings. The Committee have not been at work for any very considerable time. Their first meeting took place on July 31, 1913; and the report in your hands is just a preliminary account of the work done. I should, therefore, be pleased if Mr. Harrison will give you a short sketch of the work that has been accomplished by the Committee, and the experiments that he has performed.

Mr. W. Harrison: Mr. President, ladies, and gentlemen, I should like, in the first place, to say that the experiments which I am about to describe are merely preliminary experiments. It is a process of finding one's way to start with; and, of course, you will appreciate that a lot of work has to be done in order to find out what remains to be done. The work we have carried out has been mainly of this nature. It is intended to have experiments carried out on ventilation as it occurs in large buildings; but in order to be able to get results which are of some immediate value, although not perhaps without modification in practice, it would seem to be necessary to carry out experiments under standard con-

ditions. For this purpose, it is essential to get rid of all outside influences, and render the conditions somewhat standardized. [Mr. Harrison then proceeded to give a summary of the report.]

Professor J. W. Cobb (Livesey Professor at Leeds): Mr. President and Gentlemen, I should like to emphasize what Mr. Harrison said in dealing with this report—that it is essentially of a preliminary character, and that, although we do not mind, but rather, on the contrary, invite discussion, we do ask that, in the framing of questions, or in the directing of criticisms, the preliminary nature of the report and the conditional way in which the results are comparatively stated should be borne in mind. The real substance of what we have done has been dealt with by Mr. Harrison; but there is one point with which he has naturally not been able to deal. I, however, who, have been very directly concerned with the supervision of the work, can deal with it. I am sure that Mr. Bond and the rest of the Committee will bear me out when I say how highly the Committee appreciate the ability and ingenuity which has been displayed by Mr. Harrison, our Research Chemist, in applying himself to this work. I think, also, that Mr. Harrison, more than any other individual, is to be congratulated upon what is really a moral achievement, in having sufficient material even for a preliminary report at this stage.

Mr. J. Ferguson Bell (Derby): Mr. President, ladies, and gentlemen, I am quite sure no one will deny the importance of the subject of ventilation. So far I believe it has not been attacked in a research way, or in the scientific manner represented by the investigations which have been made at the Leeds University. I venture to say that the Institution are to be congratulated not only on having Mr. Harrison to carry out these investigations, but also that they should be under the direction of Professor Cobb, whom we are delighted to see here this morning. It was formerly often supposed that the stuffiness of a room which was heated or lighted by coal gas was due to the method of lighting and heating; but I think the experience of most people who have visited public halls and buildings which are lighted and heated by other means must convince them that it is not the method of heating and lighting which causes the stuffiness, but rather defective ventilation appliances. I noticed only a few days ago a strong report of the House of Commons upon the bad atmosphere in that chamber due to the inefficient ventilation. This defect in the House of Commons is common to all the public halls in the country. None of us can have attended large meetings without noticing how defective the air becomes if the meeting is crowded or prolonged. Therefore, I simply wish to say how pleased I am that the University of Leeds have taken up this most important question. It is very important from the public health point of view. I can conceive of no question that requires scientific investigation more than that of ventilation. The Professor need not in his opening remarks have apologized for the report. I hope it will be followed by others. I read it the other day with complete satisfaction; and I think the Leeds University are doing something in a practical manner, and they have demonstrated the advantage of the Livesey Professorship. There is no doubt that the extreme mobility of the air and changes of atmospheric pressure have led to the question of ventilation becoming a difficult one; but I venture to say that the way the matter has been tackled by this Committee and the University of Leeds will bear good fruit. In conclusion, I wish to say how much we are indebted to the Committee.

Mr. Jacques Abady (London): I merely wish to make a few brief remarks. I think the Institution is to be cordially congratulated on the appointment of this Committee, who deal with a subject which has been very much neglected in England, and badly wants investigation on scientific lines. It is obvious from Mr. Harrison's report that experiments on ventilation will necessarily have to be carried out under standardized conditions so far as the room is concerned; and I would, therefore, ask the Committee not to overlook the fact that, though experiments and the results therefrom may be made and reported under standard conditions, the practical problem which the lighting or the heating engineer has to tackle is to light and heat rooms which are by no means subject to standard conditions. I think, alongside of the experimental work that is proceeding on scientific lines, the Institution and the allied Institutions should not neglect the propaganda and educational work which is so very necessary among architects and those responsible for the designing of buildings. I am particularly anxious not to be lengthy in my remarks, because I have not yet had any breakfast, owing to the delinquency of the architect responsible for the designing of the magnificent-looking hotel where I am staying, the coffee-room of which is so constructed that if I open the windows my head is in danger of being blown off, and if I close them I run the danger of being suffocated. A question has been raised as to the difficulty of measuring the slight differences of pressure; and, if I may say so, I think if the Committee would write to my very old friend, Mr. Simmance, he could, and would, be only too delighted to help in this direction. It is rather an interesting thing to me to recall that, when I was little more than a lad, the first time I came in contact with Mr. Simmance we discussed the question of the ventilation of buildings, and the proper handling of gas-fires in connection with ventilation, *à propos* of a paper on the subject which I believe Mr. Simmance delivered in this very hall before the Liverpool Society of Arts—longer ago than I care to remember. It seems strange that we should be discussing the question here to-day. In conclusion, I would venture to emphasize a view that has often been given expression to—namely, that the gas interest in respect to ventilation, both in conjunction with lighting and heating, stands, in my opinion, in such a very strong position that those responsible for gas undertakings ought not to be content merely to remain on the defensive in this matter, but should take the offensive, and boldly ask for public support on account of the very useful assistance that gas renders in the cause of good and efficient ventilation.

Mr. J. H. Brearley (Longwood): I merely got up to point out that we have had an experiment in ventilation in this very hall this morning—in fact, while Mr. Harrison was discussing the report. I noticed that when the photograph was taken, the smoke from the magnesium flash went up to the ceiling; but by and by it came down and down, until some of our friends were enveloped in a blue mist, and Mr. Harman (seated the other side of the hall) looked very much like Mr. Harman at the gas-works. This state of things could not really have been possible if the hall had been lit by gas. I think it was a very striking experiment in ventilation, and emphasized how necessary it is for us to work in that direction.

Mr. W. J. Liberty (London): I had observed what Mr. Brearley has just referred to. We have had here to-day a practical demonstration of the fact that, if the magnificent chandelier in this hall were supplemented by a small sun gas-burner, the difficulty of the smoke from the magnesium wire would have been overcome.

Mr. F. W. Goodenough (London): I should much like to associate myself with the expression of opinion that has fallen from the previous speakers as to the value of the work that has been, and will be, done by the Committee who have undertaken this research work. I can think of no more valuable work for the good of the industry than this. I should like to express the hope that the research will lead, not merely to the presentation of reports to the Institution, but to the laying of papers on the subject before such bodies as the Royal Sanitary Institute, the Royal Institute of British Architects, the Institute of Sanitary Engineers, and others who have to deal with problems of lighting, heating, and ventilation, because it is a matter on which the members of these bodies are—I say it with all respect to them—considerably ignorant as to the value of gas in supplementing or creating ventilation in buildings. We do not merely want to carry on research work for our own information, but for the education of those who have to influence the public on these questions. I do hope that a test will be carried out, not merely on the conditions of a standard room, but to show the effect of sun-burners on the ventilation of large rooms occupied by a number of people. There are many rooms where these experiments could be carried out, such as the lecture hall of the Society of Arts. I also hope that experiments will be undertaken to show the comparative value of using whitewashed plaster in contrast with papered ceilings, and of plaster walls in comparison with varnished and papered walls, because I think the ventilation of a room is very largely affected by the character of the walls and ceilings. You could not have a worse example than this hall. I hope the Committee will take into account, and bring into their next report, the result of the investigations

carried out by Dr. Rideal in 1907, on the subject of the relative and hygienic values of electricity and gas lighting in crowded rooms. I hope also that the Committee's researches may go in the direction of determining the influence on ventilation in factories and workshops of the use of gas-stoves, because I think great benefit might be obtained in this direction. My chief point is that the present research should lead to definite propositions which would be understood, and could be applied, by the non-technical gas man; and that when we have got to practical results and propositions, that they should be laid before such bodies as I have referred to just now by men of the standing and repute of our friend Professor Cobb.

Mr. SAMUEL GLOVER (St. Helens): I should like to state one fact that is perhaps not within the knowledge of the members, and it is that in connection with the electrical chandelier in this hall there is an installation of gas heating-and-air-removing apparatus which has not been put in operation this morning. When it is working, it does all that we should have desired it to do. This, I think, emphasizes the importance of what we have been aspiring to. It seemed only right that the members should not remain in the dark with regard to this fact.

Dr. A. H. ELLIOTT (New York): The remarks made by Mr. Abady confirmed my own experience. One of my first experiences on the question of ventilation was with a small building holding some 200 students, in a lecture-room similar to this, having a fairly high ceiling. We had a good deal of difficulty in keeping the students awake. It did not make much difference who the professor was—the man who delivered the last lecture had a good many sleepy students. We came to the conclusion that the ventilation was at fault; and we proceeded to make some openings in the top of the room. I can assure you this produced a wonderful effect. When you are using up the air of an unventilated room, you have to take into consideration that you are considerably reducing the percentage of oxygen. In regard to the lecture-room I was just referring to, we found that the builder had deliberately made holes underneath the seats; and when I asked him what that was for, he said it was to let out the foul gases. But we have progressed since that time, and we do not put holes under the seats to carry off the foul air. We have a fan in the ceiling, and blow fresh air in from below. There is no reason why the ventilation should not be produced by a gas installation.

The PRESIDENT: I would like to remark that the last meeting of the Council was at Leeds; and we then had the opportunity which you have not had of seeing the apparatus at work. I am afraid you have had some difficulty in following Mr. Harrison's description; but I can assure you that we were all greatly impressed by the work done by Professor Cobb and Mr. Harrison.

The vote of thanks was then carried unanimously.

## REPORTS OF THE INSTITUTION GAS RESEARCH FELLOWS.

### I.

"THE ELECTRICAL CONDITION OF GOLD AND SILVER SURFACES DURING THE ABSORPTION OF GASES AND THEIR CATALYTIC COMBUSTION." By Harold Hartley, M.Sc.

The above report was then presented. It will be found, *in extenso*, on pp. 912-16.

Mr. HAROLD HARTLEY, introducing his report, said: The work which has been described originated in a discovery by Professor Bone, under whose direction I worked in 1905. He had then just published his important paper, in conjunction with Dr. Wheeler, which was the first of his contributions on the phenomena of combustion. After this, he was led to see whether there was any electrical charging of a metal surface while combustion was taking place. He carried out certain experiments, and felt that this opened up a new line of thought which might lead to some solution of the cause of the phenomenon known as surface combustion. For this reason, he decided that I should concentrate a certain amount of time upon the study of the problem. The work was mentioned by him in a report which he presented to the British Association in 1910; and in the discussion which followed, Sir J. J. Thompson, referring in part to this matter, made the observation which you will see I quote as showing how a physicist regards this line of attack. In the introduction to the report, an endeavour has been made to summarize that portion of scientific knowledge with regard to the electronic theory in so far as it deals with combustion and gaseous combinations. I will not touch upon this part of the report further, although I think it is demonstrated there that there is good evidence for saying that ionization is an important factor, especially in combustion.

The PRESIDENT: The value of these reports depends on whether or not you have read them. It is very interesting to listen to a chemist who has carried out the research; but to those who have not read the report I am afraid it is not of very much value. Professor Bone would like to make some observations to you.

Professor W. A. BONE (London): Mr. President and gentlemen, I am afraid that many of you, unless you have studied the report, will think that this has not much to do with your industry. I may, perhaps, explain that sometimes we have to get at the truth by what may seem to be rather peculiar means, and the research which Mr. Hartley undertook as part of his work as a Gas Fellow of this Institution at the Leeds University is dealing with a matter of very great fundamental importance. We are trying to get at something which is behind the whole question of chemical combustion and chemical affinity with gas. I believe we have made a step forward of a general character. Many physicists who have spoken to me on the subject have spoken in a very appreciative way of the important character of the work. I should much like to say that Mr. Hartley previously studied the question of the measurement of electric charges with Professor Bragg, in whose laboratory he obtained a great deal of valuable experience; and we are indebted to Professor Bragg for the advice he gave us at the beginning of the work. Mr. Hartley took up the question with great enthusiasm. He is a man of ideas, many of which he imported into this work. I consider him a very helpful and enthusiastic collaborator; and I desire here to express my appreciation of the way in which he carried out the work, and for his flow of ideas, both inwards and outwards.

The PRESIDENT: We are much obliged to Professor Bone for his remarks, and are glad to hear his high appreciation of Mr. Hartley, in which all cordially join.

### II.

(A) "THERMAL PHENOMENA IN CARBONIZATION; (B) THE INFLUENCE OF RED-HOT COKE AND RADIANT HEAT ON THE GASEOUS PRODUCTS OF CARBONIZATION." By Harold Hollings, B.Sc., and Professor John W. Cobb, B.Sc.

These communications were laid before the meeting on Wednesday. They are reproduced on pp. 917-28.

On the presentation of Section A of the report,

Professor COBB said: I have had some communications from Dr. Wheeler, which I propose to submit in writing; and M. Duchesne has also written me from Paris to say he is making a careful study of the report, and will shortly be submitting a contribution to the discussion.

The PRESIDENT: I think, gentlemen, we shall receive very great advantage from what Professor Cobb proposes to do. Of course, it is quite impossible that the discussion of this important question should be limited to what may be said at such a small gathering as this. Any communications that appear in the Technical Journals will be of great value to all of us. I may here say that we are exceedingly obliged to Professor Cobb and Mr. Harold Hollings for what they have done; and it gives me great pleasure to propose the acceptance of the report.

Mr. J. P. LEATHER (Burnley): I shall be most happy to second the acceptance of the report. The questions that have been investigated by these gentlemen have always been of great interest to me. The brief abstract we have had placed before us this morning does not, of course, tell me everything that I should like to know. The work that was done in Paris, and which was reported at the time of the International Congress in that city on this subject, is

one that I have often referred to, and read again and again as published in the "Proceedings" of the congress, with the idea of carrying on experiments in the same line myself. But one has so much to do, as an engineer and manager of a gas undertaking, that I find I have not had an opportunity of accomplishing what I wished. Therefore I am very glad that the work has been carried on by somebody else.

The adoption of the report was unanimously agreed to.

Section B of the report having been submitted in abstract,

The PRESIDENT said: I think, gentlemen, you will agree with me that the research work Mr. Hollings has been carrying out is of very great practical value. As yet, the extent of the research is small; and I have no doubt that Mr. Hollings has found, in carrying out certain work, that it will be necessary to alter his method so as to make his experiments more nearly coincide with the actual practice of gas-works. The direction in which Mr. Hollings is working is, no doubt, a very important one; and I am satisfied that the Institution will realize from the report he has given us that we shall learn something which will be very useful to us in carrying on the manufacture of gas. The matter is open for discussion; but I would remind you that our time is getting short.

Dr. RUDOLF LESSING (London): I think, Mr. President and gentlemen, that we ought not to separate without recording our appreciation of the work that has been done by Mr. Hollings and Professor Cobb. As already indicated by you, Sir, it might appear—and I certainly believe it will appear to most practical men—that papers of this kind have only an indirect influence on the processes carried out by gas engineers in their works. But the lecture by Mr. Carpenter, to which we listened a short time ago with such interest, must have taught us—not only the practical men, but also all the scientific men present—that pioneer work of the kind carried out by these gentlemen is absolutely necessary if the final masterpiece is to have any chance at all of success. It must not be thought that any engineer or chemist might go and set up, for instance, a plant of this kind simply on the basis of a few preliminary experiments. The groundwork must be completed, and ready for the use of those contemplating any great undertaking, before they can start on their work. I have only had time just to glance through the reports; but it seems to me that they are admirable subject-matter in the direction indicated. To the practical man, it might appear that a lot of the detail which is given in a paper of this kind is somewhat superfluous; and it certainly does tell him what is enough for his direct purposes. On the other hand, if work of the kind is to have any value at all, it must be based on facts sufficiently clear and full that it can be checked by others; and only if all this detail is gone into can we accept as facts the conclusion to which the investigator has come, and build up our practical work upon them. In these two reports, it seems to me very valuable groundwork has been done. In the first instance, the method of putting up a thermal balance is to me an entirely new one; and from what I can gather it seems to bear out (though attacking the problem from an entirely different direction) the older work done upon possibly a more practical scale. But the fact that the heat-balance is a comparatively small one should fill the carbonizer's heart with a desire to approach that balance, because even in the best carbonizing systems we still have to deal with a 10 per cent. fuel consumption; and if we see that the theoretical requirements are only a fraction of the total thermal values involved, there must be, for the practical man also, plenty of work to bring the carbonizing processes nearer to perfection. The second report, also in a very valuable way, confirms the results obtained by others, and certainly puts the matter in a very much clearer and more ready form for use. I am quite certain that those of you gentlemen who can spare the time to look carefully through the two reports will find plenty of work and guidance for use on a large scale, and in a practical way, in carrying on carbonizing processes. I think that we ought to record our appreciation of the report; and, if I may, I shall be happy to propose its acceptance.

Mr. R. WATSON (Doncaster): I should like, if I may, to have the pleasure of seconding the acceptance of the report, for two reasons—one that I may have the opportunity of expressing my appreciation of the work that has been done by Professor Cobb, assisted, as he has been, by Mr. Hollings. Their work will be of considerable benefit to the gas industry generally. I notice that, so far as the second contribution is concerned, it deals with the effect of red-hot coke and radiant heat on coal gas. But Mr. Hollings has told us that, in order to carry on his experiments more successfully, he has undertaken the synthetic preparation of coal, so as to see what effect takes place on the hydrocarbons. Might I suggest that he has not quite reproduced the conditions that take place in a retort, inasmuch as he has eliminated the aqueous vapour. In conclusion, I should like to ask whether it is proposed to continue the experiments in the presence of a certain percentage of moisture and a tarry vapour such as we have in an ordinary retort. I have great pleasure in seconding the acceptance of the report.

Professor COBB: Mr. President and gentlemen, I am very glad to have the opportunity of making a few remarks, because I should like to bear testimony to the patience, skill, and ingenuity which Mr. Hollings has displayed in making himself so largely responsible for the experimental part of this work. Those of you who have had any experience—particularly with the kind of work which is described in the first report—will know that it is beset with all kinds of pitfalls and difficulties; and since it is not carried out along any recognized beaten track, these difficulties have had to be solved as we went along. I therefore wish to place upon record my appreciation of the help that Mr. Hollings has rendered in this connection. Then I should like to say, with respect to both reports, that I know the time is limited, and for this reason some of you may not feel inclined to intrude upon the meeting with any observations upon them. But we shall be very pleased to answer any written questions, or to deal with any written contributions to the discussion on either report. Indeed, I may say that we should welcome this class of question and contribution. With reference to the specific question put by Mr. Watson, as to the influence of moisture and of tarry matter, I should rather like to point out, what was probably overlooked, that at the end of the report it is stated that this work is only in its first stage; and in this first stage we were particularly careful to keep out all oxygen-containing constituents, because they must be studied separately. Of course, moisture, being an oxygen-containing constituent, has, at the outset, to be excluded; but we fully realize that it will have to be studied later. I should like you to understand clearly that this is only the commencement of a piece of work which, in order to deal with it at all adequately, will probably have to form one subject of research by us, or some other people, for years to come.

The reception of the report was then unanimously agreed to.

## The Benevolent Fund.

The annual meeting of the donors and subscribers to the Benevolent Fund was held on Wednesday morning. A report of the proceedings will be found on p. 895.

## The New Officers.

The PRESIDENT announced the result of the election of office-bearers for the ensuing year as follows:

*President.*—Mr. John Bond, of Southport.

*Vice-President.*—Mr. A. E. Broadberry, of Tottenham.

*Ordinary Members of Council.*—Mr. T. Goulden, of London; Mr. T. Hardie, of Newcastle-on-Tyne; Mr. E. A. Harman, of Huddersfield; and Mr. Hubert Pooley, of Leicester.

*Auditors.*—Mr. J. L. Chapman and Mr. E. W. Drew.

*Hon. Secretary.*—Mr. W. E. Price, of Hampton Wick.

## New Members Elected.

The following candidates for admission to the Institution as members and associate members were duly elected:

MEMBERS.

Allen, Edward, jun., Liverpool Gas Company.
Bell, James, Kirkintilloch.
Bennett, C. Valon, Rochester.
Betley, Fred., Wigan.
Brentnall, John Alfred, Northwich.
Brown, John William, Barbados.
Browning, Robert A. S., Adderley Street Works, Birmingham.
Butterfield, William J. A., Victoria Street, Westminster.
Clapham, Harold, Morecambe.
Currie, Dugald, Airdrie.
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Fligg, Clarence H. M., Spennymoor.
Gregson, Walter, Eastcroft Works, Nottingham.
Harris, Clarence, Maryport.
Kay, Charles H., Douglas, Isle of Man.
Kelly, John, Bridlington.
Leech, William J. B., Leeds.
Martin, Wesley, Looe.
Nuttall, Robert H., Marsden.
Pettigrew, William M., Portadown.
Pihl, Oluf, Kristiania, Norway.
Roberts, William E., Woolton.
Shaw, Fred. Gibson, Buxton.
Salmon, John H., Skegness.
Taylor, Robert E., Haslemere, Surrey.
Tagg, Samuel, Preston.
Townsend, Charles V., Hereford.
Walton, William, Emsworth.
Wissing, Christian S., Western Works, Copenhagen.

ASSOCIATE MEMBERS.

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Bone, Charles C., Calcutta.
Bosher, George H., Aberdare.
Burton, H., Ashton-in-Makerfield.
Burton, John, Letchworth.
Large, Harry, Newport, Salop.
Morrison, Eric W., Sheffield.
Richmond, George W., Beckton.
Rogers, Rupert J., Birmingham.
Sprague, G. Trevor, Ferndale.

## THE LECTURE AND THE PAPERS.

### Purification by Heat: A Century's Progress and Its Lessons.

A lecture by Mr. CHARLES CARPENTER, D.Sc.

The lecture by Mr. Carpenter (which was then delivered) will be found elsewhere in the "JOURNAL," as also will be the papers and discussions, which were taken in the following order.

### Some Special Features in Gas-Works Practice from Norway.

By Mr. B. K. SCHIELDROP, of Bergen.

### Calorific Power as a Standard.

By Mr. JACQUES ABADY, of London.

### The Application of Coke-Oven Carbonizing and "Otto" Direct Ammonia Recovery to Gas-Works Requirements.

By Mr. GEO. T. PURVES of Chryston, near Glasgow.

### Lime and Sulphate of Ammonia as Fertilizers, and How to Increase their Sale.

By Mr. JOHN WEST, of Southport.

### Ventilation of the Congress Room.

The PRESIDENT, on Thursday morning, said: My friend the Superintendent of this building, I find, was just a little pained that we should reflect upon the ventilation of the hall. He states, as a fact, that there is no hall in Liverpool which is better ventilated; and he gave as a reason one that will appeal to you all. He said they have ventilating shafts with gas-burners in them, and that they were burning on the first day we met here. It is true that the gas-burners attached to the electric light chandelier were not in use; but they have been in operation since. Referring to the occasion of the explosion of magnesium when the photograph was taken, he says that, when a man puts 3 oz. of that stuff into his charge, and explodes it, it is too much for any building. I assured him that we were very pleased with the arrangements that had been made for our comfort.

### Société Technique de l'Industrie du Gaz en France.

The PRESIDENT: You will be pleased to hear that the following telegram has been received from our brethren in Paris:—

EDWARD ALLEN, President of the Meeting of the Institution of Gas Engineers, St. George's Hall, Liverpool.

"Remerciements pour aimable attention. Nous envoyons les meilleurs souvenirs des membres de la Société Technique et souhaits cordiaux pour complet succès meeting confrères anglais. BOUTAN, President."

[TRANSLATION.]

Thanks for kind attention. We send you the kind regards of the members of the Société Technique, and cordial wishes for the complete success of the meeting of our English *confrères*. BOUTAN, President.

### Letter from Sir Corbet Woodall.

The PRESIDENT: We have received a letter this morning from Sir Corbet Woodall, which I will give you the contents of, leaving out a little personal matter. He says: "With regard to the scholarship, I wish the proposal had been in a more definite form; but that can be put right when the Committee next meets. I wish it to be a slight reminder of the Jubilee Year."

### Honorary Members.

The PRESIDENT: Gentlemen, I have the honour to nominate as honorary members of the Institution the President of the Société Technique de l'Industrie du Gaz en France, the President of the German Association of Gas and Water Engineers, and Professor A. G. Vernon Harcourt. I desire to say that Professor Vernon Harcourt has given many years of very able service to our industry; and it is a matter of surprise that he has not at an earlier date been placed upon our roll of honorary members. However, it is not too late to do so now. Then the next is Professor John Cobb, who is a young worker in the field; but he has shown an excellent spirit, and has met with great success so far. The last is Mr. Henry Percy Maybury, who has been a gas engineer and a member of this Institution for many years. But he has recently become elevated to a far more important position. He is now the Engineer to the Road Board of the United Kingdom; and as such has done an immense amount of good in the improvement of our roads, for which motorists have to thank him. We desire this year to do ourselves the honour of having him an honorary member of the Institution. Now, gentlemen, I will put the names before the meeting, confident that you will unanimously elect them.

The resolution was carried with applause.

### Votes of Thanks.

The PRESIDENT: Now I wish to move that we convey to the Lord Mayor and Corporation of the City of Liverpool our hearty thanks for their kindness in inviting the members of the Institution to a reception at the Town Hall, and for the hospitality that has been so generously extended to them. You know, gentlemen, the kind welcome that the Lord Mayor gave to us, and the very wise words he made use of with regard to our industry being an advantage to the people. He was last evening, with the Lady Mayoress, a very courteous host. He took the most intense interest in the welfare of his guests, remaining with us till the last moment, and went away speaking very nice words with regard to our members. I am sure it is your wish that a hearty and unanimous vote of thanks should be accorded to his Lordship.

Mr. JOHN BOND (Southport): I have very great pleasure in seconding the vote of thanks. I am sure the Lord Mayor has taken the greatest interest in our proceedings, and that he takes great interest in the gas industry generally. He also takes an interest in that most important problem, the smoke nuisance. I think if the Lord Mayor had his own way Liverpool would be free of smoke, which would lead to a great saving of money on the part of the citizens. I am sure the Lord Mayor has given the whole of the members and their lady friends a most enjoyable time in this fine city. I have very great pleasure in seconding Mr. Allen's proposition.

The resolution was carried by acclamation.

Mr. JOHN YOUNG (Hull): The next vote of thanks has reference to the Chairman and Directors of the Liverpool Gas Company, for their kindness in inviting us to a reception at the Adelphi Hotel, for the hospitality which they extended to the members on that occasion, and for their kindness in giving special facilities for the inspection of

their works during our visit. There will be fresh in your minds the cordial welcome that was given by the Chairman of the Liverpool Gas Company, speaking on behalf of his brother Directors, and also the courteous way in which he referred to the aims and objects of the Institution, and to his interest in those aims and objects. This in itself was a welcome which is very dear to the professional heart; and the great kindness and hospitality shown to the members and their ladies will long be a sweet memory of our visit to the City of Liverpool. I have great pleasure in proposing this vote of thanks.

Mr. A. E. Broadberry (Tottenham): I rise with very great pleasure to second the vote. We shall all of us remember for many years the most enjoyable and successful evening that was provided for us on Tuesday. The entertainment was so handsomely conceived and carried out, that I am sure all of us would desire to place on record our hearty appreciation of the kindness shown us by the Chairman and Directors of the Liverpool Gas Company.

The vote was carried unanimously.

Mr. Alfred Tyrer (a Director of the Company): Mr. President, ladies, and gentlemen, it is quite an accident that I happen to be here; but as far as I am concerned, it is a very happy accident, because my father's and my grandfather's names were mentioned in the preamble of the Liverpool Gas Company's Bill which was drawn up nearly a hundred years ago. So I naturally take very great interest in all that appertains to the gas industry. As regards the resolution that you have so kindly proposed, seconded, and passed, speaking for my colleagues, I can only say that it gave us very great pleasure that you responded to our communication and afforded us an opportunity of doing honour to our Engineer, Mr. Edward Allen, your President, for whom we entertain the very highest esteem. I happen to be a Director of another gas and water company; and I have always found that Mr. Allen is most willing to give me every assistance, as, indeed, I have always found him willing to give everyone else assistance. So that it has been a real pleasure to all of us to be able to do anything we could during his year of office. I am sure we were all delighted to see you on Wednesday evening at the Adelphi Hotel, which I think is a very good example of an English hotel. I only regret that we do not have you here oftener. I was very glad to hear Mr. West's paper; and I hope that you will all do your best to educate your farmers, whom I regard as the finest race of men in the world, and the backbone of Old England. If you can only get them to say that they can make 9d. out of 4d., you will be doing some good, although, of course, I do not mean this in a political sense, for, personally, I do not agree with it. In agriculture we have a great lookout for our residuals, which at present are rather heavy on my chest. On behalf of myself and my colleagues, I can only thank you for this very kind expression of opinion.

Mr. R. G. Shadbolt (Grantham): I think our Hon. Secretary must have been moved by feelings of satire, when he asked me to submit the resolution that our heartiest thanks be accorded to the President and Mrs. Allen for something which I, up to now, have unavoidably been prevented from participating in. The resolution which has been put in my hands is: "That the heartiest thanks of the members be given to the President and Mrs. Allen for their cordial reception of the members during the week, and also in anticipation of the sail on the Mersey this afternoon and the visit to Eaton Hall to-morrow." From what I have heard up to the present moment, Mr. and Mrs. Allen have not spared themselves in the slightest degree in arranging for your pleasure and comfort. On this score alone, I am sure that the proposal will meet with cordial appreciation by each individual who has had the opportunity of participating in their favours. With regard to the sail this afternoon, if the President and Mrs. Allen can so exert their influence over Father Neptune that none of the ladies or gentlemen is in any way perturbed, I am sure we shall be doubly benefited. If their relationship with the meteorological office is as good as it is with the other authorities in this city, a successful outing will be assured; and it will be a fitting wind-up to what has proved to be one of the most pleasant Institution weeks. I beg to propose for your acceptance the heartiest vote of thanks.

Mr. Thomas Berridge (Leamington): Mr. President and gentlemen, I have the greatest possible pleasure in seconding the resolution so ably moved by my friend Mr. Shadbolt. I have attended all the receptions and dances, and have appreciated them very much indeed. It has been a very great pleasure to us to have the Chairman of the Gas Company and many of the Directors, not only at the opening of the first day's proceedings, but all through the day at the works, at the reception, and right the way through. Then, again, we appreciate the reception that the Lord Mayor gave us last night. Why did the Lord Mayor entertain us? Not for anything that he knows about any member. It was simply because of the respect and esteem he has for our worthy President. We know what a good man Mr. Allen is, and we appreciate highly the welcome which he and Mrs. Allen, and their family, have given us. I am sure it is only their due that we should pass them a very cordial vote of thanks.

The resolution was received with acclamation.

The President: Mr. Shadbolt, Mr. Berridge, ladies, and gentlemen,—You do me a great honour by the way you have received this vote of thanks. I feel very unworthy, but still very grateful, for your kindness; and I am, indeed, greatly honoured. Fifty years ago to this day I stood on this platform. This happens also to be the date of my wedding; and, incidentally, it is the anniversary of the Battle of Waterloo. I stood on this platform fifty years ago to-day, in connection with the Oxford Local Examination; and I had no thought then that fifty years from that time I should be receiving such honour as you have been good enough to put upon me. I can only say that my wife has joined me in this matter with great earnestness. She has tried to do her best to add to the comfort of the ladies; and we have been very happy in doing what we have been able to do. We have also the advantage of a little company of daughters who have done their best. I thank you very much, ladies and gentlemen.

Mr. R. Watson (Doncaster): Ladies and gentlemen, I have been fortunate in having placed in my hands a proposition which I think has almost been rendered unnecessary by the remarks of Mr. Berridge and the reply given by Mr. Allen. I need hardly say that the proposition has for its subject the President himself, and the conduct of the proceedings this week and the various Council meetings which have taken place during the past twelve months. I think probably it would serve the purpose if I, on behalf of the whole of the members of the Institution, and on behalf of the members of the Council, on which I have had the pleasure of serving up to to-day, express to our President our very warm appreciation of his able conduct of the proceedings here this week, and of the very excellent way in which he has steered the vessel of the Institution during the past twelve months. I think it goes without saying that we have found Mr. Allen ever courteous to the members of the Institution, ever jealous of the interests of our great industry; and combining with this the ability which he undoubtedly possesses, we have been happy in having him as our President during the year which is expiring so far as his presidency is concerned. The President has never spared himself throughout the whole of the twelve months, either on the score of time or convenience—and, I was going to say, money—in our interests; and he has placed us, therefore, under a very great debt of gratitude. We are thankful to him that in so devoting himself to our interests he has not suffered on the score of health; and we trust that the health he has enjoyed during the past twelve months will be continued for a long period. Though he will undoubtedly benefit by the holiday which I believe he contemplates taking shortly, we are glad to think this holiday has not been rendered necessary by the duties he has undertaken on our behalf. We shall ever hold you, Sir, in affectionate remembrance. May I express on behalf of the members of the Institution our great appreciation of your services.

The resolution was carried unanimously.

The President: Ladies and gentlemen, there is a vote of thanks now to be moved to the Scrutineers, the Hon. Secretary, and the Committees.

Mr. J. T. JOLLIFFE (Ipswich): Mr. President, ladies, and gentlemen, I have been asked to propose a vote of thanks to the various Committees of the Institution, the Scrutineers, and to our ever-courteous and energetic Hon. Secretary. I need hardly say it affords me great pleasure to propose this resolution.

Mr. B. W. SMITH (Walsall): I am sure that from the proceedings during the past week, and also the information that we have received from time to time, not only the Secretary but the Council have done their best to enhance the business as well as the pleasure of the members at the meeting. I have very great pleasure in seconding the proposition.

The resolution having been carried unanimously,

Mr. W. E. PRICE said: I am sure the Council of the Institution would be only too glad to individually respond to this cordial vote of thanks; but as time is short they have deputed me to do it—not officially, but I am sure that is their feeling. I am speaking now, of course, with a certain amount of knowledge, or perhaps, rather, an uncertain amount of knowledge, as being only a beginner; but still, from what I have seen, I can assure the members who do not know what the Council do that the work is something phenomenal. They will always respond to a call; and I have noticed it is not only those who reside near London who come, but even those who live furthest away from the Metropolis show a desire to do all they can to forward the interests of the Institution. What I have said applies also to the members of the Committees. If ever we want a Committee, the members are there and up to time. With reference to the other individual referred to, I do not know that I am expert enough, or have sufficient knowledge, to be able to reply for him; but still I can assure you, gentlemen, that if I have served in any way the interests of the Institution, and if I have in any way satisfied you, then my reward is in that knowledge. So long as I have your vote, I shall know I have your confidence. I shall be only too pleased to hear any suggestions as to what I can do; and it will always be my best endeavour to do anything in your interests and in the interests of the gas industry which we all have so much at heart.

The PRESIDENT: Gentlemen, we are highly favoured in our Secretary, Mr. Dunn. [Applause.] We can say nothing but what is well and good of him and of the way in which he carries out his work. He is most attentive to his duties, he has very great foresight, he looks after any details (the arrangements for this meeting, for instance, have been in his hands), and, in a word, we appreciate very highly all that he does for the Institution. I propose that we give a very hearty vote of thanks to Mr. Dunn for his services during the past year.

Mr. W. E. PRICE: Gentlemen, I have asked to be allowed to second this proposition, because I can do it with confidence, knowing as I do the amount of work Mr. Dunn has carried out during the twelve months that this vote covers.

The resolution was passed unanimously.

Mr. W. T. DUNN: Mr. President, Mr. Price, and gentlemen. I am much obliged to you, and I very deeply appreciate your kind vote of thanks. My work, especially during the past few days, has been most strenuous; but it is always a happy task for me, because I find the members are so considerate and always appreciative. The words that Mr. Price and the President have uttered will be welcome to my daughter, who helps me in London. My happiness will be hers also.

### Place of Next Meeting.

The PRESIDENT: Gentlemen, we have had a very pleasant meeting in Liverpool; and the question is where shall we meet next year? The Council have had a communication through Mr. Bond, the President-elect, asking that we shall hold our meeting in Southport next year. We have among us the Chairman of the Southport Gas Committee, Alderman Trounson, who has personally come to convey this intimation to you. It is for you, gentlemen, to consider it. There is just one fact I think I ought to mention to you, and it is that we usually meet in London each alternate year. I do not know of any case where the Provinces have been visited two years consecutively. I will content myself with saying this. I have no feeling in the matter whatever. It is in your hands, and whatever may be the outcome of it we shall very highly appreciate the invitation that has come to us through Mr. Bond in the first place, and will now I understand be extended to you by Alderman Trounson.

Alderman TROUNSON (Southport): Mr. President and gentlemen, I have been attending these meetings as Chairman of the Gas Committee for a long series of years; and I confess that I feel a certain amount of reflected glory in the fact that our Engineer is the President-elect for the coming year. I am not going to boast of the facilities, beauties, and so on, of Southport. I want you to look upon me as the mouthpiece of a resolution which is conveyed to you by the Gas Committee, asking that you hold your 1915 meeting at Southport. This resolution has since been confirmed by the Town Council. The facilities for holding such a meeting in Southport are ample. If you want any evidence of this, I would only refer you to Mr. Dunn, who has had previous experience of other Institutions visiting the town. I think I may say we have received more visits from scientific bodies than almost any other place in Great Britain. We will place all the accommodation we have at your disposal. The Gas Committee and the Corporation will do all in their power to make your visit a pleasant one; and I do not think that any of the members will suffer from experiencing a week of ozone, of which we have large quantities in store. I would like to mention the fact, referred to by the President, that it is not usual to pay a visit to the Provinces two years in succession. All I have to say on this is that if you do decide to come to Southport we shall appreciate it all the more, and take it as a signal mark of honour to the Engineer who in Southport we all admire so much. I invite you in the most cordial way to visit us in 1915.

The PRESIDENT: The question is distinctly whether we shall go to Southport next year or whether we shall go to London. I think that is the alternative. The invitation that has been given us so heartily by Alderman Trounson is a clear one—namely, that we shall go to Southport. To put the matter in order, I will deal with the amendment first—that is to ask you, by show of hands, to indicate whether you desire to go to London next year; and then I will put the question of Southport.

Mr. R. G. SHADBOLT (Grantham): If you will permit me, Sir, I think it would be more in order to put as the resolution that we accept the invitation to go to Southport. It seems to me that this is one of those exceptions which should prove the rule. Generally speaking, we meet every other year in London; but we have no rule as to where our meetings should be held. Southport, as I understand it, is a town which is blessed with facilities for holding a meeting of this kind. There they can place at our disposal a suitable building, and there are ample opportunities for social functions and plenty of accommodation. In addition to all this, the gas concern is taken an exceptional interest in by the local authority. What is there left for us to do? I say there is nothing, but to accept this kind invitation. I will propose that.

Mr. T. BERRIDGE (Leamington): I should like to be allowed to second Mr. Shadbolt's proposition. He has put the matter in such an able way that there is nothing to do except to say that I hope it will be unanimously accepted by this meeting, in the same way as it was unanimously recommended by the Council.

The PRESIDENT: I was going to mention the fact that the Council unanimously agreed to recommend the invitation for your acceptance.

The resolution was then put to the meeting, and carried unanimously.

Alderman TROUNSON: Gentlemen, I am delighted with the vote; and now that you have agreed to come to Southport, I promise that you shall have a good time.

This brought the conference to a close.

## GAS RESEARCH FELLOWSHIP REPORTS.

# THE ELECTRICAL CONDITION OF GOLD AND SILVER SURFACES DURING THE ABSORPTION OF GASES AND THEIR CATALYTIC COMBUSTION.

By HAROLD HARTLEY, M.Sc., Late Gartside Scholar of the Manchester University, and Institution Fellow at the Leeds University (1909-1912).

### Introduction.

In 1905 Bone and Wheeler, in their memoir on "The Combination of Hydrogen and Oxygen in Contact with Hot Surfaces," drew attention to the possible connection between the electrical conditions of hot surfaces and their power of rendering "condensed" or "occluded" gases chemically active. Shortly afterwards, Bone and Makower, in a series of unpublished experiments, observed that a gold surface becomes negatively electrified during the catalytic combination of hydrogen and oxygen at 300° C. or thereabouts. The research described in this paper was carried out by the author under the supervision of Professor Bone as part of his work as the Institution Fellow at the Leeds University during the years 1909 to 1912.

In order to indicate the bearing of the work upon the problem of surface combustion, it will be necessary to summarize in the introductory portion of the paper the present state of science concerning the behaviour of gases under the action of electrical forces in so far as it bears on combustion phenomena.

Surface combustion is now known to depend upon a peculiar "activation" of the combustible gas, and probably of the oxygen also, by association with the surface. At relatively low temperatures the intensity of such action varies with the chemical character and physical condition of the surface. But it rapidly increases with the temperature, until at bright incandescence there is little to choose between the catalyzing powers of chemically different surfaces—porosity and refractoriness being now the dominant factors.

In a discussion on the report on "Gaseous Combustion" presented by Professor Bone at the British Association in 1910, in which attention was drawn to the importance "of a systematic investigation of the electrical condition of heated surfaces during catalytic combustions," Sir J. J. Thompson remarked, "It was not improbable that the emission of charged particles from the surface was a factor of primary importance . . . ." and he suggested "that the action of surfaces might ultimately be found to depend on the fact that they formed a support for layers of electrified gas in which chemical charges proceed with high velocity."

If two bodies, oppositely charged to a moderate difference of potential, be supported in a dry gaseous atmosphere, it will be found that only a small current can pass between them, which current after attaining a certain magnitude is unaffected by any further increase in the potential difference until a certain critical point is reached when a large current will pass in the form of a spark discharge.

Further, it has been found that the critical potential difference requisite for such disruptive discharge diminishes with the gas pressure, down to very low pressures, but that in the highest obtainable vacua no current at all can pass, however great the potential difference.

If a luminous discharge be passed between two metal plates (anode and cathode) through a gas at low pressure, and the positive plate, or anode, be set at such an angle to the negative plate, or cathode, that the discharge impinges on the wall of the containing vessel, there will result from the impingement a stream of Röntgen or X-rays, which have the property of rendering the previously bad conducting gas a good conductor of electricity.*

In 1896 it was shown by Thomson and Rutherford that the current passing between two electrodes in air maintained in such a conducting condition will at first increase with the potential difference between the electrodes up to a certain point A (fig. 1) due to the attainment of saturation. With further increase in the potential difference, there is no further increase in the current until another considerably higher limiting condition B is attained. At the latter point there is an abrupt increase in the currents manifested by the passage of a spark. Thus the air in a good conducting ("ionized") state behaves analogously to the originally feebly conducting air; the difference between the two states being in the intensity of the currents passing.

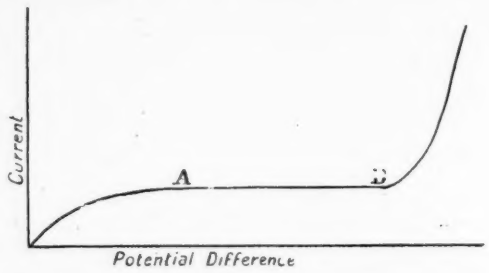


Fig. 1.

To explain these facts, it was supposed by Thomson and Rutherford that when a gas is rendered conducting there are introduced into it a number of particles either positively or negatively charged, so that conduction in gases, like that in liquids, may be attributed to the action of minute charged particles (ions). Now when such a charged gas is brought under the influence of an electrical field the positively charged particles will move towards the negative electrode, and the negatively charged particles towards the positive electrode; and the motion that is thereby set up constitutes the current flowing. The greater the potential difference between the electrodes the more rapid the flow of the particles, and consequently the current produced progressively increases. Such progressive increase of current with potential continues until a potential is reached sufficient to cause as many particles to hit the electrodes per unit of time as are produced in the gas by the ionizing cause. The attainment of this condition marks the production of the saturation current.

A gas which is capable of conducting is said to be "ionized." The properties of the "ions" are determined only by the gas and its condition, and not by their mode of formation. The fact that further increase in the current can take place at a considerably higher potential resulting in a spark discharge is due to the fact that the intensity of the field between the electrodes has itself become sufficient to produce a further supply of these particles.*

The carriers of the current in a gas vary according to its physical state. Those at normal pressure are of molecular dimensions, either single molecules or aggregates, while at low pressures the negative electron itself acts as a carrier. The increase in the size of the carrier may be traced by making determinations of its velocity of motion; the marked slowing-down which occurs at the higher pressures may be attributed to the clustering of neutral molecules around a charged particle as nucleus in a similar manner to that in which water molecules are known to collect around charged carriers, as indicated by C. T. R. Wilson's experiments.

The positive carriers, which are never smaller than an atom of hydrogen, are generally supposed to consist of the

* The luminous discharge emitted from the cathode is spoken of as the cathode rays; and these have been shown to consist of charged particles possessing unit negative charge. These rays stream out at right angles to the surface of the cathode, and, in addition to being charged, are capable of passing through certain solid bodies. It was originally suggested by Crookes that they consisted of matter in a fourth state—neither solid, liquid, nor gaseous. These rays are, in fact, electrons moving at a high velocity; seldom less than one tenth that of light. Electrons are common to all atoms and constitute the smallest particles of matter known; the mass of a single electron being about 1-1800th that of the hydrogen atom. [Mass of hydrogen atom = $1 \cdot 64 \times 10^{-24}$ grammes.] Röntgen or X-rays which are emitted from any place where cathode rays are stopped and absorbed possess great penetrating power, and travel in straight lines; they differ from cathode rays in being uncharged.

* The electrons in their migrations will be for a period unattached. Under an electrical field of great intensity they acquire during this period sufficient energy to enable them to ionize the neutral atoms of the gas, to which they do not merely adhere as under ordinary circumstances.

atom *minus* an electron, although there is some evidence of the definite existence of a positive electron. The mass of the positive carrier is at least 1800 times that of the negative electron. The negative carriers may be either free electrons or negatively charged ions. The molecules of a gas may act as carriers of electricity owing to the fact that they have obtained electrons from an outside source, such as the walls of the containing vessel, or owing to the fact that certain of the molecules have shed electrons which have been taken up by others of the molecules.

There are many ways in which electrons may be extracted from atoms. Röntgen and cathode rays have already been mentioned; but for the moment we are not so much concerned with these methods as with two other important agencies—namely, (*a*) chemical reactions, (*b*) hot solids.

Gas obtained as the result of many chemical reactions is charged electrically. For example, hydrogen, when obtained by the action of acid upon zinc, is conducting. Another familiar example is that of the bunsen flame. The gases in the flame itself, as well as the products of combustion as they stream away from the flame, are ionized. De Broglie and Brizard have shown that the products of flame combustion of hydrogen and hydrocarbons are strongly ionized, while the carbon dioxide produced by the burning of carbon monoxide has no conducting power.

Two years later this point was studied further by Bloch, whose results lead to the conclusion that the flames only of hydrogen and of substances containing hydrogen are accompanied by ionization. Haber and his pupils have devoted a considerable amount of attention to the study of the electrical condition of coal-gas flames, which they have found depends largely upon the degree of aëration. It is now almost universally held that chemical changes involve a redistribution of the electrons in the combining bodies. An initial system A, possessing a certain amount of energy, gives rise to another system B, which generally possesses less energy than A; and its formation is concomitant with the liberation of the surplus energy. This liberated energy appears mainly in the form of heat, as, for example, in the combustion of coal gas; and though a portion of the energy appears as electrical energy, the portion is very small.

When an electron is discharged from an atom, the residue left is positively charged; a positively electrified body is conceived as one which is relatively deficient in electrons, and a negatively charged body as one which possesses an excessive number. The chemical atom appears to be electrically neutral, and the view originally sketched by Kelvin, and since developed by Thomson, serves to give a mental picture of the atom. It is regarded as a sphere, a positively charged matrix through which are distributed the electrons. It is assumed that there are a large number of electrons in the atom, some of which can be expelled under certain circumstances. The chemical activity of an atom probably is dependent upon the ease with which it loses or gains electrons from its surroundings. The formation of a chemical compound can be conceived as due to the combination of two or more elements by virtue of the electrical attractions existing between their atoms.

The work of the Rev. P. J. Kirkby on the catalytic combination of hydrogen and oxygen over platinum at low pressure has a direct bearing on the work to be described, as well as his later work on the action of the electrical discharge. As the result of his first experiments, he concluded that the change "is probably connected with the corpuscular discharge which is known to be emitted by platinum." The later work led him to put forward the view that the chemical action is due to molecular dissociation effected by the collision of ions constituting the currents with molecules of the gas—the atoms thus being set free to enter into new combinations. His experiments also show that dissociated atoms of oxygen are not charged electrically. This view as to the nature of the oxygen atom is supported by some recent work by Sir J. J. Thompson, who concluded that the atoms in a molecule are probably not oppositely charged, but that the atoms are electrically neutral, containing equal numbers of opposite atomic charges of electricity; the chemical affinity being determined by the relative positions of these charges to one another.

Although the presence of ions facilitates chemical change, their mere presence does not always ensure it. Thus H. B. Baker, in his Wilde Memorial Lecture, mentioned that he had found an increase of ionization facilitated the interaction of nitrous oxide and hydrogen at 530°, the rays from radium bromide being sufficient to explode the mixture at the ordinary combining temperature. But he found also that in the absence of water ionizing agents had no effect on the combination of the gases. The union of hydrogen and oxygen is effected by certain ionizing agents, as, for example, by the electrical discharge, or by an incandescent body, but not by the mere action of ionizing rays. Here, again, it would appear that the ionization assists, but does not necessarily determine, a chemical change. On the other hand, the removal of ions is known to decrease the velocity of chemical change as indicated in a further experiment by Baker, who found that the combination of carbon monoxide and oxygen was greatly retarded when carried out under the action of a strong electrical field which would have the effect of removing ions. When considering this result, it must not be forgotten that the combination of carbon monoxide and oxygen in a homogeneous system is largely dependent on the presence of water molecules, which themselves tend to collect around ions, and might in this way be removed by an electrical field along with the ions.

Attention is also drawn to Professor W. M. Thornton's recent paper on the "Electrical Ignition of Gaseous Mixtures," in which he concludes "that some kind of ionization precedes combustion, for the evidence is strong that a relation between electrification and chemical change not unlike that of ordinary ionization occurs at ignition, caused possibly by the violent collisions which must occur in the gas in contact with high temperature sparks."

The present investigation proves that not only is there an intimate connection between the occlusion of a gas by a hot metal and its electrical condition, but also that the occlusion and ionization are antecedent to the combination of a combustible gas and oxygen under the influence of such a surface—thus establishing a link between "surface combustion" and the ionizing properties of hot surfaces.

## Experimental.

*The Apparatus.*—In the early stages of this work, difficulty was experienced in the construction of an apparatus which would be electrically tight under the required experimental conditions. The form principally used is shown in fig. 2. But for some of the later experiments another type (fig. 3) was found more convenient. In each case ebonite

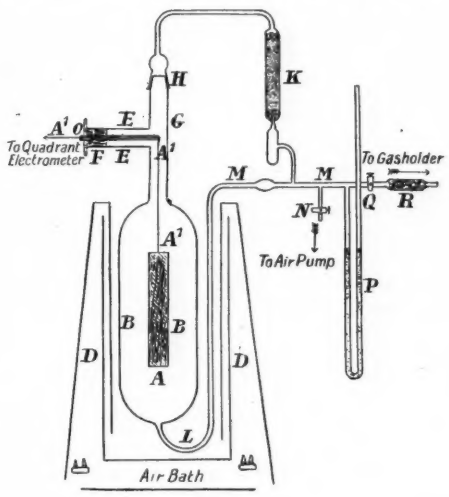


Fig. 2.

was used as the insulator. Before the termination of the work, an apparatus (fig. 4) provided with quartz stoppers, and in which quartz insulation was used throughout, had been constructed, in which the main experiments carried out in the first apparatus with gold were repeated with silver, and confirmatory results obtained.

Gold was selected, as being the most suitable metal for the principal experiments, because (1) of its marked catalyzing power at moderate temperatures, and (2) of its not forming any definite chemical compound with any of the gases under investigation—hydrogen, carbon monoxide, or oxygen; for while it is not nearly so active in promoting combustion at low temperatures as metals of the platinum group, its action is more amenable to control than theirs. Moreover, although its activity is of about the same order as that of nickel, it displays no appreciable tendency to either oxide or carbonyl formation under the required experimental conditions.

The metal was employed in the form of a gauze of fine gold wire, of 22 strands (each 0·15 mm. diameter) per centimetre, which had been specially woven by Messrs. Johnson and Matthey for Bone and Wheeler's experiments.

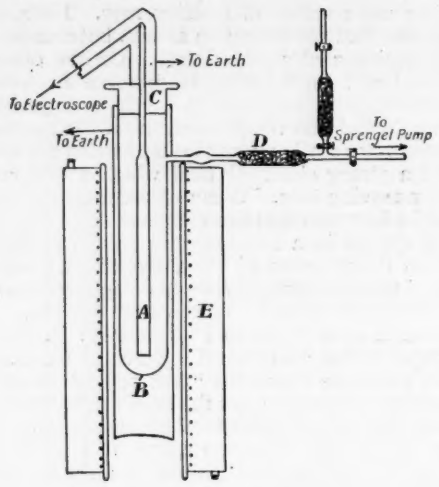


Fig. 3.

An insulated roll A (fig. 2) of this gauze was suspended from a gold wire A′ in a cylindrical Jena-glass bulb B, of about 750 c.c. capacity, which was heated to the desired experimental temperature in the air-bath D, the gas supply of which was suitably controlled. The gold wire A′ was threaded through the horizontal glass capillary tube C, which passed through the ebonite plug F. The joints between (1) the wire and glass at O, (2) the tube C and plug F, and (3) the plug F and the lateral branch E, of the main apparatus, were rendered air-tight by means of sealing wax. The gauze A thus insulated was connected, through the wire A′, with a quadrant electrometer [not shown in the diagram].

As to the remaining parts of the apparatus, the upper part of the bulb B terminated in a wide vertical tube G, leading, through a ground-glass joint H, to a tube K containing phosphoric anhydride, previously re-distilled in a current of dry oxygen over platinized asbestos. The under part of A terminated in a narrow hard-glass tube L, which was bent round, first into a vertical direction and then (after its projection out of the air-bath) into the horizontal branch M, as is shown in the diagram. Lateral branches from M served (1) to complete the circuit (through K) with the head of the apparatus; (2) for the evacuation of the apparatus through the stopcock N; and (3) for connection with the mercurial pressure gauge P. The gas under examination entered the apparatus through the stopcock Q, having previously traversed a tube R packed with glass-wool.

The difference in temperature between the bulb A and the upper part of the apparatus was sufficient to maintain a slow movement of the gas in the apparatus during an experiment, while the phosphoric anhydride in K kept it dry. The whole of the apparatus was protected from external electrostatic effects by sheathing it in aluminium foil, which was "earthed."

## Results of Experiments.

The experimental results obtained will now be summarized. For the sake of clearness, it has been decided to omit publication of the very large number of observations actually recorded, one complete set of observations being given, however, by way of illustration.

### First Series.—*Proof of Negative Charge during Combination of Hydrogen and Oxygen in Contact with the Surface.*

These experiments confirmed the previous observation of Bone and Makower. The apparatus was exhausted and the temperature of the bulb A raised to a degree (about 350°) sufficient to make the gauze chemically active towards electrolytic gas.* The electrometer was thereupon "earthed," and electrolytic gas (prepared by the electrolysis of a solution of pure barium hydroxide) was slowly admitted into the apparatus up to a pressure of 450 mm. or thereabouts. As soon as the combination of the gases in contact with the gauze had begun, as indicated by an upward movement of the manometer, the earth connection with the electrometer was broken. There was always a steady movement of the spot of light along the scale up to about 55 divisions (sensibility = 235 divisions per volt) in a negative direction, corresponding to a negative charge of approximately 0·2 volt on the gauze. Such a result could be repeated indefinitely, and the question then arose: Is it to be ascribed to the actual chemical combination of the two gases at the surface, or to the absorption of the gases by the metal which presumably precedes this combination? It was therefore necessary to study the effects produced when each gas is separately absorbed by the metal.

* The temperature indicated by the thermometer of the air-bath was doubtless higher than that of the gauze itself. Bone and Wheeler found that a temperature of 250° sufficed to make the gauze active towards electrolytic gas.

### Second Series.—*The Electrical Effect due to Absorption of Hydrogen.*

At the conclusion of the previous series, the apparatus was evacuated for three hours, and the temperature of the air-bath raised to 478°. Carefully purified hydrogen was thereupon introduced up to a pressure of 715 mm., and after a further interval of 2½ hours the electrical condition of the gauze was examined. It was then found to have acquired a negative charge of approximately 1 to 2 volts. The temperature of the enclosure was thereupon lowered to 370°, and on the following day (the gas having remained in contact with the metal overnight) the following series of observations were made, indicating a rapid charging up of the gauze after successive "earthings." The sensibility of the electrometer (charge on needle = 200 volts.) was 147 scale divisions for a charge of one volt.

| Observation. | Hour. | Temperature of Enclosure. | Electrometer Reading. Scale Divisions. |
|---|---|---|---|
| (1) | 10·46 | 362° | 0 |
| | 10·46½ electrometer earthed. | | −244 |
| (2) | 10·50 | 367° | 0 |
| | 10·50½ electrometer earthed. | | −172 |
| (3) | 10·52 | 370° | 0 |
| | 10·52½ electrometer earthed. | | −182 |
| (4) | 10·55 | 370° | 0 |
| | 10·55½ electrometer earthed. | | −176 |
| (5) | 10·57 | 373° | 0 |
| | 10·57½ electrometer earthed. | | −176 |

Observations (2) to (5) inclusive showed the gauze between each successive insulation and "earthing" acquired a negative charge of approximately 1·2 volts in 15 seconds.

The sensibility of the electrometer was then reduced to 120 scale divisions per volt (charge on needle = 80 volts), and the experiment continued. The gauze now charged up, at a rate of about 1·1 volt per minute, to a steady maximum of − 1·5 volts.

### Third Series.—*On the Electrical Effects due to the Absorption of Oxygen.*

Immediately after the conclusion of the previous series, the apparatus was exhausted; the temperature of the bath being meanwhile maintained at 370° to 390°. On admitting oxygen, the gauze continued to show a negative charge, which gradually diminished in intensity, however, during a period of several days, and finally gave place to a steady positive charge of + 0·8 volt, which subsequent experiments proved to be the true oxygen effect.

This greatly delayed manifestation of the true oxygen effect is doubtless to be ascribed to the masking effect of hydrogen occluded during the previous series of experiments, which was obstinately retained by the metal for long after the substitution of oxygen for hydrogen in the surrounding atmosphere.

Indeed, the evidence of the research as a whole pointed to two important conclusions—namely (1) that an occluded gas can only be removed with great difficulty by mere exhaustion, and will continue to manifest its peculiar effect on the electrical condition of the metal for a considerable time, even when another gas with an opposite effect is being ab-

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sorbed, so that the true effect of the latter may be for a time masked, and (2) that the charge acquired by the metal is due to gas leaving—not entering—it, after deep occlusion, a circumstance of considerable interest in connection with the phenomenon of surface combustion.

FOURTH SERIES.—*On the Electrical Effects due to the Absorption of Carbon Monoxide.*

After the conclusion of the previous series, the gauze was kept at the room temperature for a month, in contact with air. The apparatus was then heated up to 350°; and after a full day's exhaustion at that temperature pure dry carbonic oxide was admitted up to a pressure of 463 mm. For some days the gauze continued to show a positive charge, owing to the masking effect of the residual occluded oxygen from the previous series of experiments. This positive charge, as well as the rate of charging up after successive "earthings" of the metal, gradually diminished, until finally (the temperature of the apparatus having meanwhile been raised to 400°) the true negative effect of the carbon monoxide, which in two successive experiments amounted to about − 0·5 volt, asserted itself.

On subsequently lowering the temperature rather rapidly from 400° to 350°, and again testing, the gauze showed for some minutes practically no charge at all, but shortly afterwards again developed a strong negative charge. On further rapidly lowering the temperature to about 300° the same thing was again observed, namely, a temporary absence of electrical effect, followed a few minutes later by a strong negative charge, this time of − 1·0 volt. Finally, on rapidly lowering the temperature to 250°, the effect again temporarily disappeared.

The above facts would seem to indicate that the electrical effect is really due to occluded gas leaving the metal, for on rapidly lowering the temperature the outward flow of gas would be temporarily checked or lessened, producing a cessation or lag in the electrical effect, which was always a marked feature in the experiments.

FIFTH SERIES.—*Some Further Experiments with Hydrogen.*

Again, when working with a piece of silver foil in the third type of apparatus shown in fig. 4, further evidence of the effect of the bulk movement of the gas molecules was obtained.

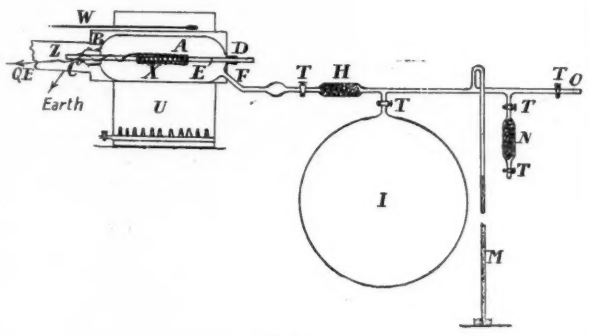


Fig. 4.

The apparatus consisted of a Jena glass tube provided with a broad limb B, into which at one end is ground a perforated silica stopper C. At the opposite extremity of the Jena glass tube two narrower limbs were provided, one D for the support of the silica tube E, around which was wrapped the silver foil and wire X; the other F to connect with the remainder of the apparatus, which consisted of a mercury trap H, the large bulb I, of about two litres capacity, and a mercury manometer M. Arrangements were made (1) for admitting the gases under operation through the tube N, which was packed with cotton wool to remove pre-existing ions, and (2) for evacuating the whole or any part of the apparatus by means of a Sprengel pump attached to O. Tubes were provided as shown by T. The gas-heated furnace employed is shown at U. The Jena tube was surrounded by an earthed metal shield Z.

The large bulb I could be employed for reducing the pressure in the tube A by keeping it evacuated and then suddenly opening to A, or as a reservoir for gas, such as the hydrogen, in the following experiments. The furnace was regulated to maintain the temperature recorded by the thermometer W as constant as possible.

The fluctuations in temperature indicated were much greater than that undergone by the silver surface, as the thermometer was in the stream of the burnt gases coming away from the furnace. The piece of silver foil in the apparatus had been heated in the hydrogen and then allowed to cool down in this gas. The furnace was lighted and the bulb I filled with pure hydrogen; the remainder of the apparatus being evacuated.

MAY 22, 1911.

10.30 a.m.—Pump set going. Furnace heated up to 500° C. Pump hammering by 11 a.m. Temperature lowered somewhat.

3.15 p.m.—The furnace temperature was now at 400° C. The pump had been kept working all the morning.

*Charge on the "Hydrogenized" Silver.*

Earth reading of quadrant electrometer = 287.
Q.E. needle at + 200 volt.
Sensibility = 287 → 384 for − 1/3 volt = 97 divisions.
287 → 475 for − 2/3 volt = 188 divisions.
Earth contact broken at 3.24 p.m.

| Time. | Reading of Q.E. | | |
|---|---|---|---|
| 3.24 p.m. | 287 | | Main drift of the gas is *outwards* from the "hydrogenized" metal into the Sprengel vacuum outside. |
| 3.26 | 297 | | |
| 3.28½ | 307 | | |
| 3.31½ | 317 | | |
| 3.34½ | 327 | | |
| 3.38½ | 337 | | |
| 3.44 | 347 | Pump kept hammering. | |
| 3.57 | 357 | | |
| 4.1½ | 387 | | |
| 4.40 | 441 | | |
| 4.50 | 446 | | |
| 4.55 | 448 | | |

Temperature = 426° C.
Earth reading at end 291.

4.57 p.m.—Hydrogen now admitted from bulb I.

| | | |
|---|---|---|
| Q.E. earth reading | = | 290 |
| Manometer | = | 483 mm. Hg. |
| Barometer | = | 753·4 mm. Hg. |
| Pressure of hydrogen | = | 270·4 mm. |
| Temperature | = | 425° C. |

| Time. | Reading of Q.E. | | |
|---|---|---|---|
| 5.0 p.m. | 290 | | Main drift of gas is now *inwards* into the metal. |
| 5.2 | 296 | | |
| 5.4 | 299 | | |
| 5.5 | 300 | | |
| 5.6 | 303·5 | | |
| 5.8 | 307 | Q.E. now seems to be charging up at only about half the rate it was while the apparatus was being evacuated by the Sprengel pump. | |
| 5.10 | 311·5 | | |
| 5.12 | 315 | | |
| 5.14 | 318·5 | | |

Silver left to stand in contact with hydrogen for a short time.

5.20 .. 334

Q.E. earthed. Earth = 290.

| Time. | Reading of Q.E. | |
|---|---|---|
| 5.23 | 290 | |
| 5.25 | 296 | |
| 5.27 | 302 | |
| 5.28 | 305 | |
| 5.30 | 310 | Temperature as registered = 418° C. Temperature now raised. |
| 5.33 | 317·5 | do. 430° C. |
| 5.53 | 421 | do. 436° C. |
| | | Q.E. earthed. |
| 5.55 | 290 | |
| 5.56 | 301 | |
| 5.57 | 310 | |
| 5.59 | 321 | The Q.E. now charging up much faster than it was then Hydrogen was first put in, also faster than when evacuation was taking place. |
| 6.0 | 327 | |
| 6.8 | 356 | |

Temperature as registered = 425° C.

Probably at first after admitting the hydrogen the main drift of gas was into the metal, and some time was required for a dynamic equilibrium to be established, and for any appreciable increase in the rate of diffusion of gas outwards to take place.

While the previous observations were being recorded, the bulb I was evacuated. The pressure in A was now suddenly lowered by connecting it with I. The large increase in the rate of charging-up of the metal is indicated by the following results.

| | | |
|---|---|---|
| Manometer | = | 723 mm. Hg. |
| Barometer | = | 753·4 mm. Hg. |
| Pressure of hydrogen | = | 30·4 mm. |
| Temperature | = | 427° C. |

| Time. | | Reading of Q.E. | |
|---|---|---|---|
| 0 sec. | .. | 290 | Earth = 230. |
| 30 | .. | 306 | |
| 60 | .. | 319 | |
| 90 | .. | 332 | |
| 100 | .. | 337 | |
| 150 | .. | 356 | |
| 180 | .. | 367 | |
| 200 | .. | 375 | |
| 240 | .. | 388 | |
| 247 | .. | 390 | Q.E. earthed. |

Temperature = 430° C.

| Time. | | Reading of Q.E. | |
|---|---|---|---|
| 0 | .. | 289 | Earth = 289. |
| 60 | .. | 320 | |
| 90 | .. | 335 | |
| 120 | .. | 349 | |
| 150 | .. | 362 | |
| 180 | .. | 375 | |
| 200 | .. | 383 | Sensibility = 289 → 384 |
| 220 | .. | 389 | for − 1/3 volt = 95 divisions. Q. E. earthed. |

Temperature = 432° C.

| | | | |
|---|---|---|---|
| 0 | .. | 287 | |
| 30 | .. | 305 | |
| 60 | .. | 321 | |
| 90 | .. | 337 | |
| 120 | .. | 350 | |
| 150 | .. | 364 | |
| 200 | .. | 384 | |
| 216 | .. | 390 | |
| 250 | .. | 406 | Still moving. Q. E. earthed. |

The surface was now charging up at a rate between six and seven times as great as during the last observation immediately prior to the sudden lowering of the hydrogen pressure.

In further support of the foregoing view may be cited some later observations on the effects of successive sudden reductions in pressure upon the magnitude of the negative charge on an insulated silver rod maintained at a constant temperature in an atmosphere of pure dry carbon monoxide. The effect of a sudden reduction in pressure would be to increase temporarily the outward flow of occluded gas from the metal, which, according to the above rise, should be accompanied by an increase in the intensity of the negative charge.

A rod of pure silver A (fig. 3), 3 mm. diameter (flattened at one end to 5 mm.), was fitted in a Jena glass tube B by means of an ebonite plug C, through which it was connected with the leaf of a Wilson tilted electroscope. The capacity of the apparatus was purposely made as small as possible, so as to permit of rapid lowering of pressure in the gaseous atmosphere surrounding the rod. A bulb D containing granulated silver was inserted to prevent any passage of mercury vapour on to the surface. The actual observations were made after the rod had been heated in contact with carbon monoxide at atmospheric pressure for a week, during which it had consistently shown a marked negative charge. The temperature of the electric furnace E was suitably adjusted; and starting with a pressure ($P_{co}$) of 754 mm. the effect of successive rapid diminutions in pressure upon the negative potential rod were recorded, as under:

| — | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $P_{co}$ | 754 | 389 | 186·5 | 106·5 |
| Deviation of the electroscope leaf | 36 | 55 | 61·0 | 72 0 |
| Deviation for a charge of − 2/3 volt on electroscope leaf | 68 | 70 | 70·0 | 76·0 |

The marked rise in the negative potential of the rod after each successive reduction in the pressure of the carbon monoxide atmosphere clearly indicated that the electrical effect is due to occluded gas leaving the metal.

### Sixth Series.—*Experiments on the Combination of* $2\,CO + O_2$ *over Gold.*

To complete the investigation, it only remained to carry out a series of observations upon the effect of the combination of a mixture of carbon monoxide and oxygen, in their combining proportions, in contact with the gold gauze similar to those already made (first series) in the case of electrolytic gas. For this purpose, a U-tube, containing solid caustic potash, as well as a long glass spiral immersed in liquid air, were sealed in series into the upper part of the apparatus outside the air-bath, to remove any carbon dioxide formed. As rapidly as possible the temperature of the air-bath was raised to 370°; and after prolonged exhaustion at this temperature the mixture of carbon monoxide and oxygen in their combining ratios was admitted. The gauze rapidly developed a negative charge of − 0·7 to − 0·85 volt, which was repeatedly re-established within a minute after each of many successive momentary "earthings" of the metal.

### Conclusions.

The results of the investigation may be summarized in the following conclusions:—

(1) A gold surface acquires a negative charge during the catalytic combustion of gases in contact with it.

(2) This electrical effect is probably antecedent to the actual combustion, and is primarily due to "occlusion" phenomena.

(3) The metal becomes negatively charged during the occlusion of the combustible gas (hydrogen or carbon monoxide), and positively charged during the occlusion of oxygen.

(4) Such electrical effects are probably due to occluded gas which is leaving (rather than entering) the metal. Any cause, such as a sudden lowering of temperature, or a sudden increase in pressure, which would momentarily check the outflow of occluded gas, will likewise diminish the intensity of the charge, or may even momentarily stop it altogether. Conversely, a sudden diminution in the outside gaseous pressure in the vicinity of the metal, which would increase the rate of outflow of the occluded gas from the metal, will temporarily increase the intensity of the electrical effect.

(5) Such temporary disturbances in the intensities of the electrical effects as are described in (4) are probably due to the fact that a change in either temperature or pressure of the system is accompanied by a change in the dynamic equilibrium between the in-going and outflowing gas at the surface system, which change lags behind the exciting cause.

The investigation of the subject is being extended to other surfaces by Professor Bone, in the new Department of Chemical Technology at the Imperial College of Science and Technology, London; and the author desires to thank him for his assistance in drawing up this report.

## APPENDIX.

### *Description of the Quadrant Electrometer.*

The quadrant electrometer originally devised by Lord Kelvin, and since considerably modified, is an apparatus for accurately measuring the potential of a body. The particular form used during the investigation is known as the Dolezalek electrometer, and was made by the Cambridge Scientific Instrument Company. It consists essentially of a squat hollow cylinder divided into four equal segments suitably spaced and supported on insulating rods. A light needle, composed of paper coated with very thin aluminium foil, and provided with a light rigid arm to which is attached a small mirror, is suspended by a thin conducting thread from an adjustable support in such a way that the needle hangs symmetrically with reference to the quadrants. Opposite pairs of quadrants are in electrical contact; and during an actual experiment one pair is permanently connected to earth (zero potential), the other pair being connected with the surface under examination. The needle is brought to a high potential by connecting it to one pole of a battery of small secondary cells the other terminal of which is earthed. Under these conditions, the deflection of the needle, as indicated by the movement of a spot of light reflected from the small mirror on to a graduated scale, is proportional to the potential on the surface being examined. Then if the direction and extent of the deflection produced by a known potential is known, the potential of the surface can be calculated.

Just prior to, and immediately after, each determination of the potential on the surface during the foregoing investigation, the latter was momentarily "earthed," by means of a suitable "make and break," to determine the zero reading. The sign of the charge was indicated by the movement of the needle to the right or to the left, as shown during the calibration of the instrument.

# GAS RESEARCH FELLOWSHIP REPORT.

## (A) "THERMAL PHENOMENA IN CARBONIZATION."

## (B) "THE INFLUENCE OF RED-HOT COKE AND RADIANT HEAT ON THE GASEOUS PRODUCTS OF CARBONIZATION."

By HAROLD HOLLINGS, Gas Research Fellow, and JOHN W. COBB, Livesey Professor.

[Contributed from the Laboratory of the University of Leeds.]

**Summary of Report on One Portion of the Work carried out by Harold Hollings (Gas Research Fellow) during the Years 1912-13 and 1913-14.**

### THERMAL PHENOMENA IN CARBONIZATION.

By HAROLD HOLLINGS, B.Sc. (Gas Research Fellow) and JOHN W. COBB (Livesey Professor).

A number of chemical studies have been made of the distillation of coal—such as those of Burgess and Wheeler in this country and of Vignon in France; but the thermal phenomena during distillation have received very much less attention, so that it seemed to us that a research in this direction was more than justified. The thermal phenomena during distillation might be defined as those temperature changes occurring during distillation which are different from the changes that would occur during the heating of an inert substance, such as coke or fire-clay, through the same temperature range.

Apart from the intrinsic importance which attaches to heat absorptions or evolutions due to inside chemical changes in any fuel-using process such as carbonization, it was thought that the correlation of the results obtained with those obtained by purely chemical means might be useful, and that observations in the one field would most probably suggest points for investigation in the other.

We have examined in some detail the work of Mahler, Constam, Euchêne, Barnum, and others on the thermo-chemistry of carbonization; and from the work that has been done on the relationship between the calorific values of coal and its distillation products, it appears that the distillation is exothermic when the calorific values are determined at ordinary temperatures (a convention in thermo-chemical tables). But we consider that the question is still open so far as concerns the heat evolved or absorbed during the actual process of distillation at the temperatures used.

Our own work was not particularly directed towards the determination of the net quantities of heat involved in distillation, but, having regard to the complicated sequence of reactions which inevitably occurs, was an attempt to see how far it was possible to divide the process into thermal stages—(1) heat absorbing, (2) heat evolving, and (3) thermally neutral.

The method we employed consisted in heating, side by side under the same conditions, a coal which underwent distillation and a coke (which could be regarded as chemically and thermally inert), and noting, by means of the differential arrangement of thermo-couples devised by Roberts-Austen (Proc. Mech. Eng., 1899, 38) for the examination of metallic alloys, the extent to which the temperature of the coal became higher or lower than that of the coke at various stages of the distillation. Complications arising from the secondary decomposition of distillation products were minimized by using a small quantity of coal and sweeping away the products by a stream of inactive nitrogen.

Bituminous coals, anthracites, cannel coal, cellulose, and dehydrated cellulose have been examined by this method. We do not consider that the heating curves obtained afford any quantitative data as to the net thermal result of carbonization; but it would seem that, in the case of all the typical coals examined, the net quantity of heat involved is very small, since there are both exothermic and endothermic reactions taking place. At certain temperatures it is not improbable that both exothermic and endothermic reactions do take place simultaneously—thus considerably increasing the difficulty of detecting such changes by the experimental method we employed.

One interesting fact in connection with all the curves for coals so far obtained is that in no case have we found any evidence of a sudden decomposition at any definite temperature, such as the exothermic decomposition of pure cellulose. The decomposition of coal appears to consist of a very complicated sequence of reactions which extend over a wide temperature range. In all cases the distillation, so far as it is revealed by thermal changes, commences at 250° C.; and between this temperature and 1100° C. we have detected a number of fairly-well defined stages during which exothermic or endothermic reactions predominate.

In attempting to explain the various phenomena observed, we have encountered considerable difficulty, owing to the lack of chemical data respecting the products evolved from coal at different temperatures. Such fractional distillations under experimental conditions comparable with ours, as have hitherto been carried out, have been between quite arbitrary temperature limits, and the most attention has been given to the permanent gases evolved, whereas those phenomena, chemical or physical, which give rise to the expulsion of vapours condensing to liquids on cooling, are probably accompanied by thermal effects at least as large as those caused by the expulsion of permanent gases.

We have attempted to correlate the results obtained by Burgess and Wheeler and Vignon with the thermal change we observed at 750° C.; and we hope that, as more chemical data respecting the sequence of chemical changes which take place during carbonization become available, a much more complete explanation of the results of our research will be possible. Further, the critical points noted in the heating curves may suggest the temperatures at which it would be more profitable to carry out fractional distillations of coal.

As a further attempt to elucidate the phenomena observed, we intend to obtain the heating curves of those portions of coal soluble and insoluble in pyridine or other solvents, and also to examine the dehydrated cellulose in further detail.

### (A)

### "THERMAL PHENOMENA IN CARBONIZATION."

#### Introductory and Critical.

A number of chemical studies have been made in the laboratory of the carbonization of coal—such as those of Burgess and Wheeler in this country, and of Vignon in France; but the thermal phenomena during carbonization have received very much less attention, so that a research in that direction seemed to us more than justified. This paper consists of a critical *résumé*, which seemed advisable, of work that has already been carried out by other investigators on the thermo-chemistry of carbonization, and a summary of our own experimental work and its results. The thermal phenomena during carbonization might be defined as those temperature changes occurring during carbonization which are different from the changes that would occur during the heating of an inert substance, such as coke or fireclay, through the same temperature range.

Apart from the intrinsic importance which attaches to heat absorptions or evolutions due to inside chemical changes in any fuel-using process such as carbonization, it was thought that the correlation of the results obtained with

those obtained by purely chemical means might be useful, and that observations in the one field would probably suggest points for investigation in the other.

### The Work of Mahler.

The first recognition of the importance attaching to the investigation of the thermal side of distillation seems to have been by Mahler, who in 1891 ["Compt. Rend." CXIII., p. 862] examined the products of distillation of Commentry coal. He determined the yield of each product (coke, tar, and gas), and its calorific value. The results show that the calorific value of 100 kilos. of coal exceeds that of the products by 25,479 calories, which figure represents 3·5 per cent. of the calorific value of the coal. The generally accepted interpretation of this result is that this quantity of heat is evolved as a net result of the chemical actions taking place during distillation, and is, therefore, not available as potential energy in the products. One assumption must, however, be made before this can be taken as strictly correct. The calorific values are not determined at the distillation temperature, and hence the heat supplied to the coal in raising it to the distillation temperature, and that abstracted from the products during cooling, have to be considered.

Thus if $x$ be the heat absorbed during distillation (*i.e.*, the negative heat value of the reactions involved.)

Pc the calorific value of the coal

Pp the calorific value of the products

$Sc \frac{Td}{T}$ the thermal capacity of the coal between the temperature T at which Pc is determined and the mean temperature of decomposition Td

$Sp \frac{Td}{T}$ the thermal capacity of the products between the same temperatures.

$$\text{Then } Pc + Sc \frac{Td}{T} + x = Sp \frac{Td}{T} + Pp.$$

$$\text{Whence } x = Pp - Pc + Sp\frac{Td}{T} - Sc \frac{Td}{T}.$$

In the ordinary interpretation of Mahler's result it is assumed that $x = Pp - Pc$—*i.e.*, that $Sp \frac{Td}{T} = Sc \frac{Td}{T}$, which is not necessarily correct. Unfortunately, we have not reliable figures for the mean specific heats of coal and some of its products; but if a calculation is made making certain reasonable assumptions, it will be found that the difference between Sp and Sc may be considerable when compared with the value of $x$ found by Mahler.

In this connection it is interesting to note that Klason, Heidenstam, and Norlin ["Chem. Zentr.," 1909 (1) 109], in drawing up a similar heat-balance for the distillation of wood, assumed a reaction temperature, and have taken account of the specific heats in their calculations.

More recently Constam, Kolbe, and Schlapfer ["Journal of Gas Lighting," 1908, CIII., p. 382, and 1909, CVII., p. 696] have determined the calorific value of coal and its products in a similar manner to Mahler. The figures for 28 English and Continental coals have been given, and in each case the calorific value of the coal exceeds that of its products—the quantities ranging from 2·1 per cent. to 7·2 per cent. of the net calorific value of the coal (see Tables IV. and V.). Also these authors quote Poole as having, in 1898, found the calorific value of an American coal to exceed that of its products by 3·06 per cent.

There have just been published ["Gas World," 1914, LX., p. 36] figures by Frankenfeld showing the distribution of the heat units of the coal among the products of carbonization in inclined retorts, and the figures are in very close agreement with Mahler's laboratory experiment.

In all these cases (with the exception of that of Klason) it is assumed that the difference between the calorific values of coal and of its products is the same at ordinary temperatures as it is at the distillation temperature.

### The Work of Euchène and Barnum.

Euchène [International Gas Congress, Paris, 1900; "Journal of Gas Lighting," Vol. LXXVI., pp. 1080 and 1141] has attacked the problem in an entirely different manner; and since his figures are the result of very careful work, and are often quoted in connection with the thermochemistry of carbonization, we have examined them in some detail. Briefly, Euchène has drawn up a heat-balance of a retort-setting. Thus if

A is the heat furnished by the fuel in the grate

$x$ the heat absorbed during distillation

C the heat carried away by the flue gases

D the heat carried away by the volatile matter leaving the retort

F the heat lost by radiation

E the heat retained by the coke drawn from the retort

H the heat carried away by ashes and clinker

$$\text{Then } A = x + C + D + F + E + H$$
$$\text{or } x = A - (C + D + E + F + H)$$

Note: Euchène also calculated the heats of formation of the various products from their elements (B – G), and hence deduced X, the heat of formation of coal from its elements. For the sake of simplicity, we have omitted these terms.

In 1906 Barnum [Proceedings New England Association of Gas Engineers, 1906, p. 58; "Journal of Gas Lighting," Vol. XCIV., p. 239] determined the heat-balance of a regenerative setting in a similar manner to Euchène. In the following table, Euchène's and Barnum's results are summarized.

Table I.

| | 1. | 2. | 3. | 4. | 5. |
|---|---|---|---|---|---|
| A Heat of fuel . . . . | 151,816 | 143,683 | 135,550 | 100,304 | 119,791 |
| C Flue loss . . . . . | 89,962 | 81,311 | 76,712 | 32,649 | 67,110 |
| D Heat in volatile matter . | 16,680 | 17,999 | 20,017 | 17,999 | 12,963 |
| E Heat in coke . . . . | 25,573 | 24,585 | 23,087 | 24,585 | 18,727 |
| H Heat in ashes. . . . | 1,344 | 1,272 | 1,200 | 1,184 | included in C |
| F Radiation loss . . . | 23,596 | 22,114 | 20,885 | 25,306 | 11,628 |
| C + D + E + F + H . . | 153,155 | 147,281 | 141,901 | 101,723 | 110,428 |
| $x$ = A – (C + D + E + F + H) . . . . . | – 1,339 | – 3,598 | – 6,351 | – 1,419 | + 9,363 |

Column 1 gives Euchène's figures for coal No. 2 in ordinary setting.
" 2 " " No. 3 "
" 3 " " No. 4 "
" 4 " " No. 3 in regenerator setting.
" 5 gives Barnum's figures converted from B.Th.U. per 100 lbs. to K.C.U. per 100 kilos, so that they are comparable with Euchène's figures.

It will be seen that the values of $x$ found by Euchène agree in sign with those already quoted. Although Barnum's result is so different, not only in degree but in sign, this is often overlooked. Indeed, Lewes ["The Carbonization of Coal," p. 124] quotes Barnum's results as confirming those of Euchène.

### Probable Errors in Euchène's Method.

Euchène found the value of $x$ to be – 3598 K.C.U. per 100 kilos. of coal for coal No. 3 when distilled in a non-regenerative setting (Col. 2 in Table I.) and – 1419 K.C.U. when distilled in a regenerative setting (Col. 4). This might possibly be explained in part by the different conditions of distillation in each case. It is well known that if the conditions of distillation—*e.g.*, the rate of heating-up the coal and the temperature of the retort walls in the early stages of distillation—are altered, the products obtained will be different. In this case the value of $x$ (the heat absorbed in the change from coal to distillation products) will be altered. [Note that the value of X, the heat of formation of coal from its elements, is unaffected.] A study of Euchène's calculations shows that he has assumed the conditions of distillation and the products formed to be the same in both retort-settings. A more probable explanation of the difference between the two results found is that the figure is within the limits of experimental error. A large number of measurements and certain assumptions are necessary to determine the various heat losses from the setting. In view of the deductions which have been made from Euchène's values of $x$, his own words in this connection may be quoted. "On peut même se demander *a priori* si la valeur qu'on trouvera ne pourra pas être classée parmi les causes d'erreurs." ["Transactions Gas Congress," p. 240.] Again on p. 296 he says: "Cette quantité de chaleur (viz., $x$) étant faible, on pourrait supposer qu'elle est de l'ordre des erreurs possibles."

It will be seen from the table already given that the value of $x$ is very small compared with the heat quantities involved in its deduction. It is interesting to note that Euchène

admits a large error in the heat-balance of the regenerative setting. In this case a separate balance was drawn up for the producer, furnace, and regenerator, as the following summary shows.

[The terms X, B, and G are omitted as before.]

TABLE II.

*Producer.*

| | | | |
|---|---|---|---|
| $A_1$ Heat of partial combustion of coke | 43,212 | Sensible heat of producer gas | 22,434 |
| Experimental error | 1,418 | $A_2$ Decomposition of water vapour | 15,318 |
| | | H Loss in ashes | 1,184 |
| | | $F_1$ Radiation | 5,694 |
| | 44,630 | | 44,630 |

*Regenerator.*

| | | | |
|---|---|---|---|
| Heat in gases leaving furnace | 57,370 | C Flue loss | 32,649 |
| | | $F_2$ Radiation | 2,386 |
| | | Heat in sec. air to furnace by difference | 22,335 |
| | 57,370 | | 57,370 |

*Furnace.*

| | | | |
|---|---|---|---|
| Sensible heat in gas | 22,434 | Heat in gases to regenerator | 57,370 |
| ,, ,, air | 22,335 | D Heat in volatile matter | 17,999 |
| $A_3$ Heat of combustion | 72,410 | E Heat in coke | 24,585 |
| | | $F_3$ Radiation | 18,644 |
| | | | 118,598 |
| | | $x$ | − 1419 |
| | 117,179 | | 117,179 |

In the condensed summary of these three balances in Col. 4 of Table I., we have subtracted the error 1418 from the radiation loss in order to avoid introducing a separate item. If, however, this error is in the determination of the sensible heat of the producer gas, it will be carried forward to the furnace balance-sheet, and the value of $x$ will become − 2437, an increase of 100 per cent.

In Euchène's work the possibility of error mentioned in connection with Mahler's method is eliminated, since he is concerned with the heat quantities at the distillation temperature. But in view of the error to which the value found for $x$ is subject, one should be very cautious in drawing conclusions from the results obtained.

TABLE III.

| — | Oxygen in Coal. | Volatile Matter. | $x$ |
|---|---|---|---|
| Coal II. | 5·94 | 25·99 | 12·39 (*a*) |
| Coal III. | 6·82 | 28·30 | 35·98 (*b*) |
| Coal IV. | 8·73 | 32·17 | 63·51 |

(*a*) This should be 13·39; there is a misprint in the original paper.
(*b*) The alternative value 14·19 may be quoted.

Lewes [*loc. cit.*, p. 118] reproduces Euchène's figures (Table III.), and states: "These results show in a striking way that the heat liberated increases in nearly regular ratio with the amount of volatile matter in the coal, and that the more oxygen the coal contains the more endothermic its reaction—a fact which points clearly to its being the oxygen-bearing compounds in the coal which give it its endothermic character." We have been interested to ascertain how far Constam and Kolbe's results support these hypotheses. The results are summarized in the following tables.

TABLE IV.—*English Coals.*

| — | Net C. V. in B.Th.U. | $x$ = per Cent. C.V. | $x$ in K.C.U. per k.g. Dry Ashless Coal. | Volatile Matter. | Oxygen. |
|---|---|---|---|---|---|
| Nottingham | 13,918 | 6·0 | 463 | 43·63 | 10·20 |
| ,, (best hard) | 14,072 | 4·4 | 343 | 39·60 | 9·24 |
| Low Main | 14,859 | 4·0 | 329 | 36·01 | 5·66 |
| Ballarat | 15,109 | 3·6 | 303 | 26·40 | 4·22 |
| Kinneil | 14,494 | 3·5 | 282 | 38·40 | .. |
| Trencherbone | 14,602 | 3·1 | 252 | 29·96 | 7·05 |
| Hutton | 15,235 | 2·9 | 246 | 33·14 | 3·70 |
| Barnsley | 14,324 | 2·5 | 199 | 33·26 | 7·92 |
| Nixon's | 15,271 | 2·1 | 178 | 21·52 | 2·58 |

The relationship between the volatile matter and $x$ is not good, and two coals (Trencherbone and Barnsley) are out of place if the oxygen content is considered.

TABLE V.—*Continental Coals.*

| — | Net C.V. in B.Th.U. | $x$ = per Cent. C.V. | $x$ in K.C.U. per k.g. Dry, Ashless Coal. | Volatile Matter. | Oxygen. |
|---|---|---|---|---|---|
| Pyrenean | 13,563 | 6·68 | 501 | 42·85 | .. |
| Gardanne | 12,346 | 7·2 | 493 | 49·40 | 14·0 |
| Mausegatt | 15,073 | 5·67 | 475 | 12·62 | .. |
| Bruay | 14,196 | 6·0 | 473 | 37·90 | .. |
| Gladbeck | 14,562 | 5·76 | 465 | 31·86 | 6·3 |
| Sonnenschein | 15,282 | 5 1 | 433 | 19·07 | .. |
| Girondelle | 15,120 | 4·93 | 413 | 15·59 | .. |
| Amercoeur | 15,237 | 4·8 | 407 | 9·88 | 1·73 |
| Ronchamp | 15,094 | 4·5 | 377 | 22·10 | .. |
| Blanzy | 14,097 | 4·8 | 376 | 34·60 | .. |
| Epinac | 14,954 | 4·4 | 365 | 10·85 | .. |
| Chapelle-sous-Dun | 13,415 | 4·4 | 328 | 43·40 | .. |
| Lenz | 15,030 | 3·7 | 309 | 28·00 | .. |
| La Mure | 14,551 | 3·6 | 291 | 7·40 | 1·36 |
| St. Etienne | 15,046 | 3·3 | 276 | 29·65 | .. |
| Ostricourt | 15,121 | 3·2 | 269 | 10·35 | .. |
| Flötz Robert | 15,120 | 3·01 | 253 | 22·40 | .. |
| Grand' Combe | 14,814 | 2·6 | 214 | 20·20 | .. |
| Meurchin | 15,192 | 2·2 | 185 | 12·65 | .. |

In the Continental coals (Table V) there is no agreement between the volatile matter in the coal and the heat evolution ($x$); but the four cases in which the oxygen content is given support Lewes's hypothesis that the oxygen-bearing compounds in the coal are responsible for the heat evolution. When one considers the exothermic nature of many of the oxygenated compounds found among the distillation products, it does not seem improbable that the oxygen-bearing compounds in coal are in part responsible for the heat evolution; but in this connection it should be remembered that some of the other products (including methane) are also highly exothermic.

Chorley and Ramsay ["Journal Society Chemical Industry," 1892, pp. 395 and 872] found a very marked evolution of heat during the distillation of various forms of cellulose; and they attributed this to the formation of such exothermic compounds as acetic acid, methyl alcohol, the oxides of carbon, and water.

Bantlin ["Journal fur Gasbeleuchtung," 1914, LVII., pp. 32 and 55] and Buttner and Wislicenus ["Journal prakt. Chem.," 1909, LXXIX., 177] have also noted qualitatively that the distillation of cellulose is exothermic, while Klason [*loc. cit.*] has calculated the following heats of reaction at 275° C.: Cotton, 152 calories; fir wood, 317 calories; pine, 223 calories; birch, 289 calories; beechwood, 316 calories; the quantities in the case of the woods being about 6 per cent. of the heat of combustion.

Summarizing the work that has been done on the relationship between the calorific values of coal and its distillation products, it appears that the distillation is exothermic when the calorific values are determined at ordinary temperatures (a convention in thermo-chemical tables). But we consider that the question is still open so far as concerns the net total heat evolved or absorbed during the actual process of carbonization at the temperatures used.

Our own work was not particularly directed towards the determination of the net quantities of heat involved in distillation, but, having regard to the complicated sequence of reactions which inevitably occur, was an attempt to see how far it was possible to divide the process into thermal stages—heat absorbing, heat evolving, thermally neutral.

## THE AUTHORS' EXPERIMENTAL METHOD.

The method we employed consisted in heating side by side, under the same conditions, a coal which underwent carbonization and a coke which could be regarded as chemically and thermally inert, and noting by means of the differential arrangement of thermo-couples devised by Roberts Austen [Proceedings Mechanical Engineers, 1899, 38] for the examination of metallic alloys, the extent to which the temperature of the coal became higher or lower than that of the coke in various stages of the distillation. Complications arising from the secondary decomposition of the distillation products were minimized by using a small quantity of coal and sweeping away the products by a stream of inactive nitrogen. These precautions would modify such thermal changes in the interior of a large mass of coal undergoing carbonization as have been observed by Bond ["Inst. Gas Eng.," 1905].

The essential parts of the apparatus used are shown in fig. 1.

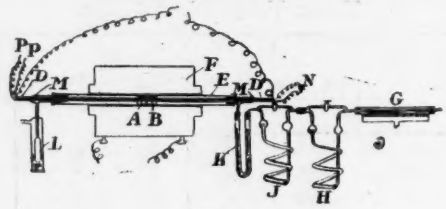


Fig. 1.
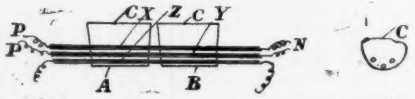
Fig. 2.




Fig. 3.

The coal and coke were heated in very thin fireclay boats —an enlarged view of which is given in fig. 2. A is the boat containing the coke, and B that containing the coal. Fig. 3 gives the end view of the boat, and shows the three holes through which pass the long thin silica tubes D, giving necessary protection to the thermo-couples. C is a lid of nickel gauze to keep the coal in position during heating after it has been packed round the silica tubes in the boat. This lid is held down by pushing it under the curved sides of the boat, as shown in fig. 3.

The coke standard is previously prepared by packing the coal in A, and then heating it to a temperature of 1100° C. in an atmosphere of nitrogen.

E is the porcelain tube in which the boats are placed, and is heated by an electric furnace F. At each end of the porcelain tube E is fitted a rubber cork and glass T-tube. The silica tubes D pass through the porcelain tube and extend beyond the T-tubes at each end. Nitrogen from a cylinder is passed through (1) a heated glass tube G containing copper gauze to remove oxygen, (2) a spiral H containing an alkaline solution of pyrogallic acid to remove the last traces of oxygen, (3) a spiral J containing concentrated sulphuric acid, and (4) a U-tube K containing calcium chloride to remove moisture. The nitrogen thus purified passes through the T-tube into the porcelain tube E, as shown in fig. 1. The nitrogen and the volatile products of distillation leave the porcelain tube through the other T-tube, and then pass through sulphuric acid in the bottle L. This seal prevents the diffusion backwards of air, serves to detect any large leak on the apparatus, and by maintaining a slight pressure in the apparatus prevents the diffusion inwards of air through any small leak.

The silica tubes D are passed through the boats A and B, being held in position relative to the boats by means of a little fire-clay, and the thermo-couples are threaded through the silica tubes. The two couples to be connected in opposition, so as to show the difference between the temperature of the coal and that of the coke, are arranged with their hot junctions at X and Y (fig. 2) in the centres of the coke and coal respectively. Z is the hot junction of the thermo-couple which records the actual temperature of the coke. The coal is placed in the boat as described. The boats and silica tubes are then placed inside the porcelain tube so that the boats come in the centre of the furnace. The corks and T-tubes are fitted to the porcelain tube, and the joints between the T-tubes and the silica tubes D are made gas-tight by means of wax at M. The two platinum leads of the thermocouples X and Y are joined together at N, and the two platinum-rhodium leads P are joined by copper leads direct to the "differential" galvanometer. The junctions with the copper leads are made under water in a bottle well protected with cotton wool, so as to maintain both junctions at the same temperature. The two leads from the thermocouple Z were connected through a cold junction maintained at 16° C. to the Carpenter-Stansfield potentiometer, by means of which the actual temperature of the coke was measured.

After expulsion of air from the apparatus, a sample of nitrogen leaving the porcelain tube was collected, subjected to analysis, and found to be free from oxygen and oxides of carbon. After thoroughly drying-out the furnace tube (before introducing any coal), the amount of water vapour leaving the apparatus was estimated by absorption in a calcium chloride tube, and found to be negligible. Thus the distillation of the coal is carried out in a perfectly inert atmosphere.

### The Heating of the Furnace.

The combined length of the two boats is about 6 cms., and a preliminary trial showed that the temperature of the furnace was satisfactorily constant over that range. After a few experiments had been made, 7° C. per minute was found to be the most suitable rate of heating; but it was found to be important to maintain a very uniform rate of heating throughout the experiment. This was done by gradually increasing the current passing through the furnace by decreasing an external resistance in series with the furnace. To increase the possible delicacy of adjustment of the current passing through the furnace, one rheostat was connected in parallel with the furnace. Special arrangements were also made for the supply of current at a very steady voltage.

### The Use of Coke as a Standard Body.

In the selection of a standard body alongside which the coal may be heated, there are two main considerations. The body should have a thermal capacity not very far different from that of the coal, and it must be capable of being raised in temperature at a perfectly uniform rate—*i.e.*, it must not exhibit any thermal changes itself. Thus in the examination of metallic alloys a cylinder of the alloy may be heated alongside a similar cylinder of platinum—a body which undergoes no molecular change on heating. But as platinum would be attacked by the volatile products of the distillation of coal, its use as a standard in this case would be inconvenient. Moreover, coke is a body with a thermal capacity nearer that of coal. The crucial question is whether it exhibits any thermal changes itself. An early and somewhat crude experiment, in which a few grammes of powdered coke were heated in a boat of nickel gauze alongside the platinum standard used in metallurgical work, showed that there was no very serious change in the coke. Later and more delicate experiments, in which the coke standard was heated alongside (1) a boat containing ignited fireclay, (2) a boat containing ignited silica sand (Curve No. 14*), and (3) an empty boat, all confirmed this view. A close examination of many of the figures obtained would suggest that either in the coke or in the apparatus immediately surrounding the thermo-couples, there is some very slight thermal change at a temperature of about 640° C. The exact significance of this has not as yet been investigated, since it is very small compared with the larger changes taking place in the coal.

Powdered coke was at first used as a standard, but was soon abandoned in favour of a standard which had been prepared from coal packed into the boat as already described. The coal shrinks during the later stages of carbonization, and thus a very good contact is obtained with the tubes surrounding the thermocouples. At the outset, a suitable vessel had to be found in which to heat the coal. As nickel is a substance which exhibits no serious thermal change, boats made of nickel gauze were at first tried; but it was afterwards found much more convenient to use the fireclay boats with lids of nickel gauze, as shown in figs. 2 and 3. These were made by casting fireclay slip in plaster, and they contain 3 to 3½ gms. of coal.

### The Carpenter-Stansfield Potentiometer.

The Carpenter-Stansfield potentiometer is a modification of the pattern described by Stansfield ["Phil. Mag." 1898, XLVI., 66]. In this instrument the electro-motive force of the thermocouple is almost balanced by another accurately known electro-motive force (which can be quickly changed to any desired multiple of 400 micro-volts). Hence a very delicate galvanometer can be employed, and at the same time the deflections of the needle can be confined within narrow limits. These deflections are noted by means of a beam of light reflected by a mirror on to a scale placed 42 inches from the galvanometer. The thermocouple used for the measurement of the temperature of the coke standard was calibrated by noting the freezing points of various metals—using, of course, the potentiometer.

The deflection of a second galvanometer connected to the differential thermocouples was noted by a beam of light reflected on to the same scale. A difference of 1° C. between the temperatures of the two differential couples gave (at temperatures between 10° C. and 50° C.) a deflection on the scale of 2 mm.

Both galvanometer deflections are noted each minute, and

* See Appendix, p. 923.

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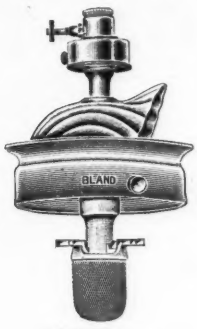


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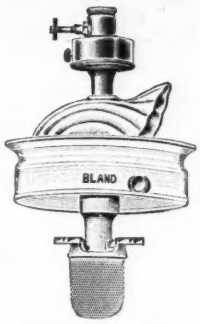


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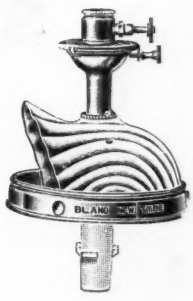

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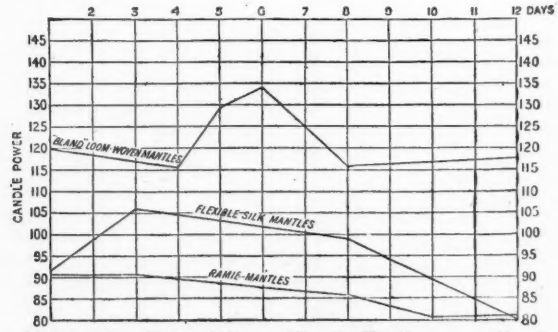
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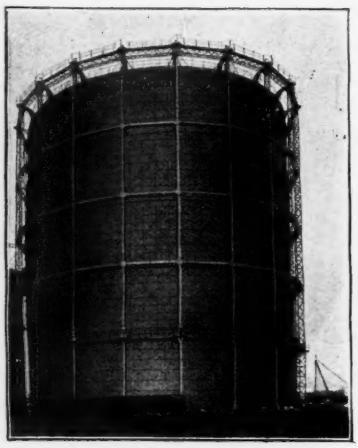

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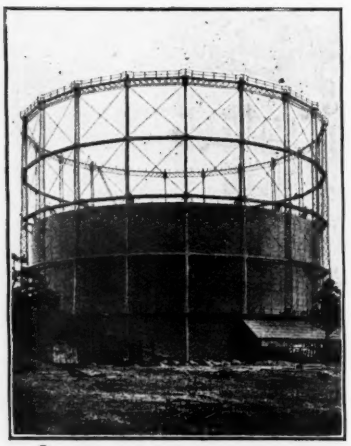

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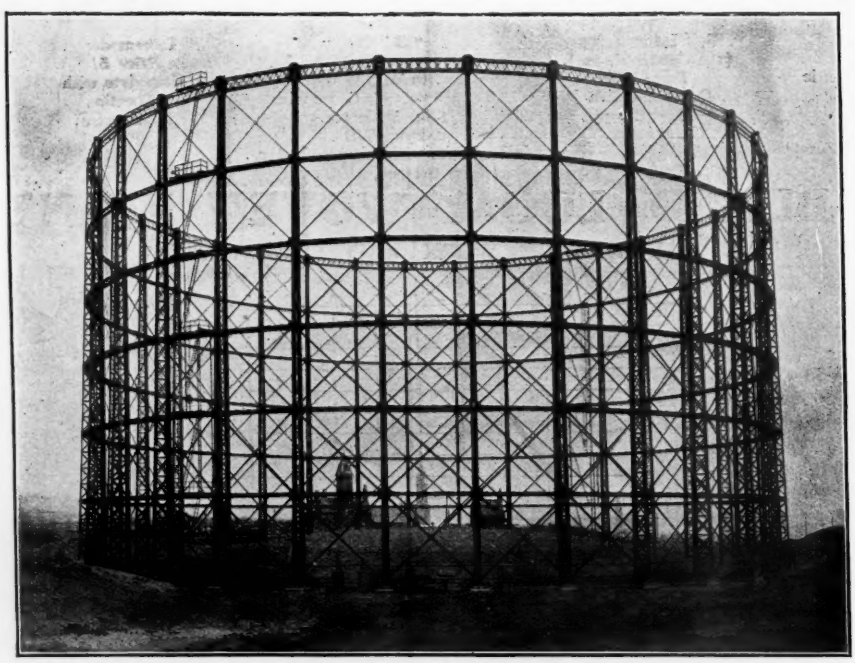

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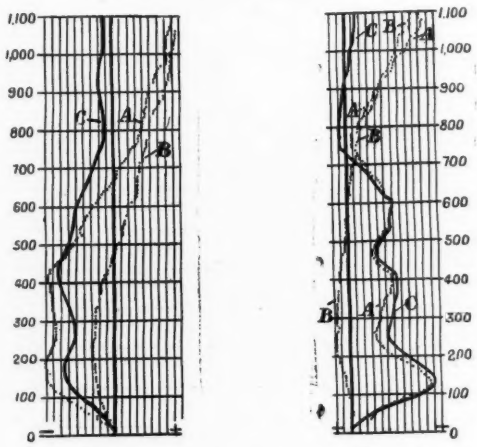
then the differences in temperature between the coke and coal are plotted as abcissæ against the actual temperatures of the coke as ordinates.

The coal which has been examined in most detail is a sample of picked nuts from the Monckton Main seam, the composition of which is as follows:—

| | Per Cent. |
|---|---|
| *Volatile matter | 40·20 |
| Ash | 5·43 |
| Carbon | 72·36 |
| Hydrogen | 4·93 |
| Sulphur | 1·64 |
| Nitrogen | 1·53 |
| Oxygen | 14·11 |

* Determined in a platinum crucible by the 1899 method of the American Chemical Society.




Curve 1. Curve 2.

**Bituminous Coal, Monkton Main.**

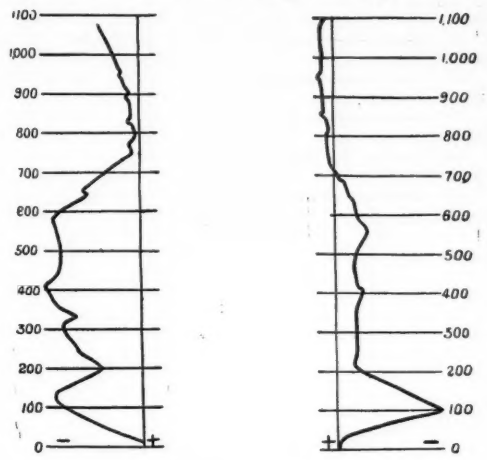
In the above diagram the dotted curve A represents the actual heating curve of the coal, each dot represents a minute reading (as explained above), and the deflections on the + *ve* side of the vertical zero line show that the coal is hotter than the coke and *vice versâ*. Each division to the right or left represents a deflection of 2 mm.—*i.e.* (assuming the electromotive force of each couple to be a linear function of the temperature) a temperature difference between coke and coal of 1° C. These divisions are not inserted in the following curves; but all the curves reproduced in this paper are drawn to the same scale.

One cannot be quite certain that, independent of the changes which take place in the coal, the two differential thermocouples will be raised in voltage at the same rate. The two couples were made from the same batches of wire, so they should give as nearly as possible the same voltage at the same temperature. But there are other possibilities. The constant range of the furnace may not be the same at all temperatures; and there may be some difference in the heat conductivity of the boats and of the silica tubes surrounding the thermocouples. Therefore, in all cases after obtaining the curve A the furnace was allowed to cool, and a blank curve was taken by repeating the heating. Thus the dotted curve B represents the heating curve of the two cokes —*i.e.*, the coke standard in the one boat and the coke made in the other boat during the experiment. Now if the curve B is subtracted from A, we obtain the curve C, which represents the changes which take place during the distillation of the coal. The validity of the correction due to the blank curve B has been repeatedly tested by reversing the positions of the coke standard and the coal in the furnace. Thus the standard used for Curve 1 was replaced by fresh coal, which was heated alongside the coke resulting from the distillation of the coal used for Curve 1. The correction was obtained and applied in the same manner as before, and it will be seen that in general characteristics Curve 2C is the reverse or image of Curve 1C.

Referring to the corrected Curves C, it will be seen that at first the coal lags behind the coke in temperature. This is probably due to the lower heat conductivity of the coal. It is not due to the expulsion of moisture, since in all cases the coal was dried for one hour at 110° C. before being placed in the boat. The turning point occurs between 100° C. and 150° C., and the explanation of this presents some little difficulty, since it is hardly possible that between 150° C. and 250° C. there can be any exothermic reaction in an inert atmosphere. It was noticed that the extent of the deflection at 150° C. varied considerably in different experiments; and this is believed to be due to the uncertainty in the rate of heating of the furnace at the commencement of an experiment. Owing to the very rapid rise in the resistance of the furnace, it was found almost impossible to secure uniform heating during the first 200° C. Thus it seems most probable that the second part of the curve up to 250° C. simply represents a return to normal conditions. In all cases there is a very decided turning point at 250° C., showing that there start at that temperature reactions which absorb heat. This stage is interrupted at about 420° C. by a change in the slope of the curve which indicates heat evolution. Between 460° C. and 610° C. there seems to be another stage representing heat absorption; then the heat evolution continues until some temperature between 750° C. and 800° C.

### The Rate of Heating.

The results obtained at different rates of heating may now be given. A curve (not reproduced in this paper) was obtained when the rate of heating was 2° C. per minute. In this case the distillation takes place so slowly that there is sufficient time for the temperatures of the coal and coke to become equalized before the temperature of the coal (relative to that of the coke) can be altered to any marked extent



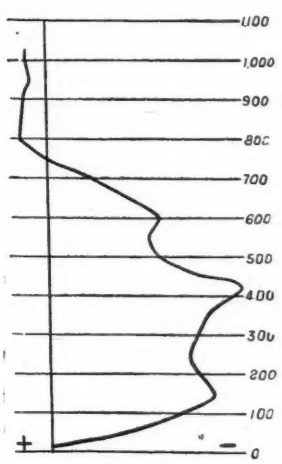

Curve 3. Curve 4.

**Bituminous Coal, Heated 4° C. per Minute.**

In these and all following diagrams the "corrected" curve only is given.

by internal changes. Hence we do not find in this curve the large deflections noted with the quicker rates of heating, and the curve obtained does not exhibit any marked changes. The only turning point of which there is any distinct evidence is that at 750° C.

When the furnace is raised in temperature 4° C. per minute (Curves 3 and 4), the turning points are more marked; but there is still a difficulty arising from the tendency to irregular heating at these slower rates.




Curve 5.

**Bituminous Coal Heated 12° per Minute.**

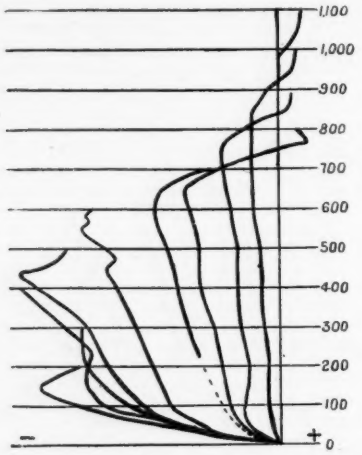
When the temperature is raised 12° C. per minute (Curve 5) a smoother curve is obtained, since the maintenance of uniform heating is easier. But at this rate of distillation it

is doubtful whether sufficient time is allowed for the completion of changes which normally take place at a given temperature before that temperature is considerably exceeded. Thus in Curve 5 it will be seen that the turning point usually found very little above 750° C. was about 800° C., showing that the distillation was too rapid for the completion of the stage usually completed at 750° C.

The above considerations led to 7° C. per minute being adopted as the standard rate for raising the temperature; and all the curves reproduced in this paper were obtained at that rate except where otherwise stated.

### The Possible Influence of Conductivity.

The question might at once be asked whether the different slopes in the curves obtained really represent the absorption and evolution of heat due to the chemical changes which take place during distillation, or whether they represent successive changes in the heat conductivity of the coal during distillation. A special series of experiments was carried out to investigate this question. The heating curve was taken in the usual way up to 200° C. The furnace was then allowed to cool immediately, after which a heating curve up to 300° C. was taken. In this way, each successive heating of the same coal was taken 100° C. higher up to 1100° C.




Curves 6
**Bituminous Coal.**

The curves obtained (corected in the usual way) are all plotted together for comparison (Curves 6). It has already been pointed out that the difference between the conductivity of coke and coal largely determines the magnitude of the initial deflection. Hence if any marked change in conductivity takes place at any given temperature, we might expect a marked difference between the early part of a curve obtained before the coal had been heated to that temperature, and the early part of a curve obtained after the coal had been heated to that temperature. Reference to Curves 6 will show that (excepting, possibly, at about 300° C.) throughout the distillation there is a steady improvement in the conductivity of the coal. The most marked improvements are noticed after heating to 500° C. and 600° C., which is quite in accordance with what might be expected when it is remembered that the caking of the coal takes place at about that temperature.

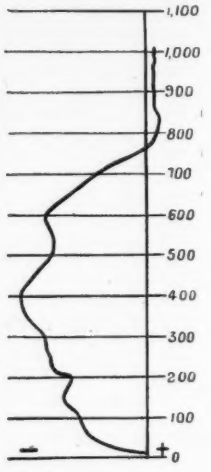
It was thought that if a small difference in conductivity could account for the deflections noted in the heating curve of coal, very large deflections would be noted if the coke was heated alongside substances of such a low conductivity as ignited powdered-fireclay or ignited silica sand. But it was found that the deflections obtained in such experiments were quite small. [The curve obtained for silica sand is interesting in another connection—see Appendix]. These experiments led us to conclude that the heating curves of the coal were not unduly complicated by the varying heat conductivity of the coal as it is carbonized. Further confirmation of this was received by the very similar behaviour, on heating, of coke as formed in the boat in one piece, and of the same coke powdered and filled loosely into the boat.

### Stages in the Heating Curves.

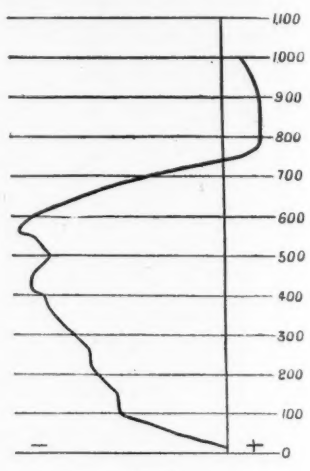
We will now return to a consideration of each separate stage in the heating curve of the coal. One attempt to elucidate the various phenomena consisted in heating the coal up to various temperatures suggested by the heating curves, under conditions similar to those under which the curves were obtained, and determining the loss in weight of the coal. But all that could be learned from these simple experiments was that when the coal is raised in temperature 7° C. per minute, the maximum rate of loss in weight occurs at a temperature of about 400° C.

It has already been pointed out that the first stage of the curves, up to 150° C., is believed to be due mainly to the lower heat conductivity of the coal. It was found that about four hours' drying of the coal in the furnace at 100° to 110° C. immediately prior to taking the heating curve did not affect the general character of the curve.

Curve 7 shows the result obtained after previously distilling the coal for six hours at 300° C. The stages in the curve below 300° C. are only partially obliterated, and it would seem that six hours is not a long enough period for the completion of the changes taking place below 300° C.



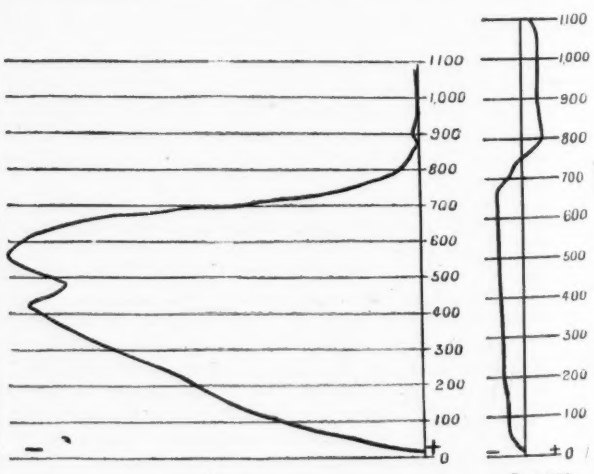

Curve 7.
**Bituminous Coal after Distillation at 300° C.**




Curve 8.
**Bituminous Coal after Distillation at 400° C.**

Curve 8 is the heating curve after previous distillation for three hours at 400° C. to 414° C. Again, one cannot be certain whether the preliminary heating has completed the changes which take place below 400° C. Curve 9 is much more decisive. It shows the heating curve obtained after a preliminary distillation for 24 hours at 350° C. to 360° C. In this curve we see that the stages below 400° C. have been obliterated, but that above 400° C. the other stages are still quite clear.

If the interpretation given for Curves 6 be accepted, those stages in the heating during which the coal tends to increase in temperature more rapidly than the coke are not simply the result of an improving heat conductivity of the coal. It was considered possible, however, that they represented a return to normal conditions—that is, an equalization of the temperatures of coke and coal—immediately after an endothermic stage of the distillation process. It was largely to investigate such a possibility that these particular experiments were performed. In Curve 9, we find that the stage

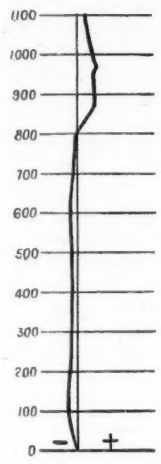



Curve 9. Curve 10.
**Bituminous Coal after Distillation for 24 hours at 350° C. — At 650° C.**

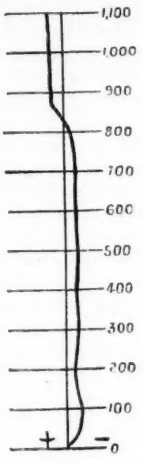
between 420° C. and 470° C. still persists, in spite of the fact that all distillation at 360° C. must have been completed before this heating curve was commenced. It seems, therefore, to be established that exothermic changes do take place between 420° C. and 470° C.

Proceeding in a similar manner to the 610° to 750° C. stage, Curve 10 was obtained after a previous distillation at 600° to 650° for three hours. In this case all changes below 650° C. are obliterated, but above that temperature the exothermic stage continues. It was thought desirable to ascertain if 24 hours' distillation at 650° C. would complete this exothermic stage; but the curve obtained [not reproduced] showed that such was not the case.

Curve 11 was obtained after previous distillation for three hours at 750° C.; and it is very significant that even in this case the exothermic stage still continues up to 890° C.

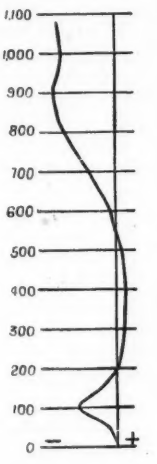



Curve 11.




Curve 12.

**Bituminous Coal after Distillation at 750° C.**




Curve 13.

**Bituminous Coal after Distillation at 850° C.**

Curve 12 was obtained in confirmation of this observation. Curve 13 shows that three hours' distillation at 850° C. has almost obliterated all thermal changes.

On referring back to Curve 6 (actually obtained after Curves 11, 12, and 13), it will be seen that there again the exothermic stage continues up to higher temperatures after a preliminary heating. [In this case the heating was not prolonged at any temperature, and thus we still find evidence of the exothermic change even after a preliminary heating to 1000° C.]

A possible explanation of these results is that the exothermic reactions start at 610° C. and continue until some high temperature is reached; but that at about 750° C. there start other endothermic reactions, which in the ordinary heating curve mask the exothermic effect above that temperature. Further, while prolonged heating at 750° C. does not effect completion of the exothermic reactions, it would seem that it does complete the endothermic reactions, since after a preliminary heating at 750° C. there is evidence of exothermic reactions up to 900° C.

## Summary and Conclusions.

The heating curves of coal obtained in this research do not afford any quantitative data as to the net thermal result of carbonization; but it would seem that the *net* quantity of heat involved is very small, since there are balancing exothermic and endothermic reactions taking place. At certain temperatures it is not improbable that both exothermic and endothermic reactions take place simultaneously, thus considerably increasing the difficulty of detecting such thermal changes by the experimental method we employed. One interesting fact in connection with all the curves so far obtained is that in no case have we found any evidence of a sudden decomposition at any definite temperature, such as occurs in the exothermic decomposition of cellulose. The decomposition of coal appears to consist of a very complicated sequence of reactions which extend over a wide temperature range. In the case of the Monckton coal used, the distillation, so far as it is revealed by thermal changes, commences at 250° C., and endothermic reactions predominate up to 410° C. This is followed by a short exothermic stage between 410° C. and 470° C., and a second endothermic period between 470° C. and 610° C. The exothermic stage above 610° C. is always very pronounced, and is interrupted between 750° C. and 800° C. The probability that exothermic reactions continue to some higher temperature has already been discussed.

We are continuing our experiments to the examination of different types of coal; and so far as we have gone, it may be said in general terms that the same stages are in evidence, modified, as is not surprising, by the nature of the particular coal under examination.

In attempting to explain the various phenomena observed, we have encountered considerable difficulty owing to the lack of chemical data respecting the products evolved from coal at different temperatures. Such fractional distillations under experimental conditions comparable with ours as have hitherto been carried out, have been between quite arbitrary temperature limits, and most attention has been given to the permanent gases evolved, whereas those phenomena, chemical or physical, which give rise to the expulsion of vapours condensing to liquids on cooling may be accompanied by thermal effects at least as large as those caused by the expulsion of permanent gases.

Burgess and Wheeler in their study of the volatile constituents of coal ["Journal Chemical Society," 1910 (ii) 1917 and 1911 (1) 649] have shown that there is a critical point in the distillation of coal at some temperature between 750° C. and 800° C., and that when this point is reached there is a large and sudden increase in the quantity of hydrogen evolved, while methane is more prominent among the products evolved at lower temperatures. This observation has been fully confirmed by Vignon ["Compt. Rend.," 1912, 155, 1514.] Though methane is an exothermic body—*i.e.*, it is formed synthetically with an evolution of heat—it by no means follows that all the reactions which give rise to its formation are exothermic.

It is an interesting point that the figures of Euchène, Mahler, and Constam and Kolbe for the heat quantities evolved in the carbonization of coal are of the same order of magnitude as the heat quantities which can be calculated as likely to be involved in the formation or decomposition of methane. In the interpretation of results obtained in this research, it should be remembered that complications arising from the secondary decomposition of volatile products after leaving the mass of coal have been eliminated; but it is impossible to say how much secondary change takes place within the pores of the newly-formed coke.

It seems to us quite probable that the heat evolution noticed above 610° C. in our heating curves may be connected with those reactions which give rise to the production of methane. It has already been pointed out that this heat evolution is not due to one single reaction, but to a sequence of reations. These reactions are interrupted at about 750° C. by others which give rise to the formation of large quantities of hydrogen. It is hoped that as more chemical data respecting the sequence of chemical changes which take place during carbonization become available, a more complete explanation of the results of this research will be possible. Further, the critical points noted in the heating curves may suggest temperatures at which it would be more profitable to carry out fractional distillations.

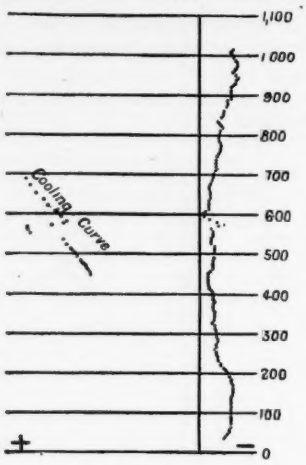
As a further attempt to elucidate the phenomena observed, we propose to obtain the heating curves of those portions of coal soluble and insoluble in pyridine or other solvents, and of substances of known composition.

## APPENDIX.

In the heating curve for silica sand [see p. 924] we find interesting evidence of one of the transformations which quartz is known to undergo on heating.

It will be seen that in the heating curve there is evidence of a heat absorption which commences at a temperature of 570° C., due presumably to some molecular change within the silica. The reaction is reversible, since a heat absorption occurs at a temperature of about 580° C. on cooling. Endell has published ["Stahl und Eisen," 1913, No. 45] the equilibrium diagram for the $SiO_2$ system, which shows that $\alpha$ quartz is only stable below 575° C., and that above that temperature it tends to pass into $\beta$ quartz. Presumably the thermal phenomena noticed in this experiment with silica are due to this transformation. This is of interest to us, because the same heat evolution has been noticed in practically all the heating curves obtained in this research, due to

the fact that quartz-tubes have been used for the protection of the thermocouples. In order to avoid confusion, this small deflection due to the quartz transformation has been as far as possible omitted in drawing the "corrected" curves




Curve 14.

**Silica Sand.**

as they are reproduced in this paper. [The extent of this deflection may be seen in Curve 1A.] The same phenomenon has been noticed with both the transparent and the opaque varieties of fused quartz-tubes.

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## (B)

## "THE INFLUENCE OF RED-HOT COKE AND RADIANT HEAT ON THE GASEOUS PRODUCTS OF CARBONIZATION."

In connection with modern developments in carbonization, many statements have been made respecting the breaking-down of volatile products as a result of contact with the surface of hot coke, or of the action of heat radiated from the walls of the retort, or both. But most of the observations have been made on large-scale carbonization processes, in which, owing to the complexity of the phenomena studied, it is very difficult to isolate cause and effect with any certainty. The need has been widely felt of experimental work under laboratory conditions in which the various factors would, as far as possible, be under control, and could be varied singly at will.

The experiments of Burgess and Wheeler on the distillation of coal are very useful as indicating the nature of the products evolved at various temperatures; but in their experiments the gases were removed as quickly as possible in order to prevent subsequent changes. It is these changes with which our experiments are primarily concerned.

Coal distillations were, in the first place, carried out under various conditions, so that satisfactory preliminary evidence might be obtained as to the influence of red-hot coke and radiant heat on the whole of the gaseous products of distillation. A Nottinghamshire (New Hucknell) gas coal was used, the composition of which was as follows:—

| | Per Cent. |
|---|---|
| *Volatile matter | 37·3 |
| Ash | 3·77 |
| Carbon | 77·36 |
| Hydrogen | 5·66 |
| Sulphur | 1·65 |
| Nitrogen | 1·34 |
| Oxygen | 10·22 |

* The volatile matter was determined in a platinum crucible by the 1899 method of the American Chemical Society.

The apparatus used was modified from time to time; but its general character will be understood from fig. 1.

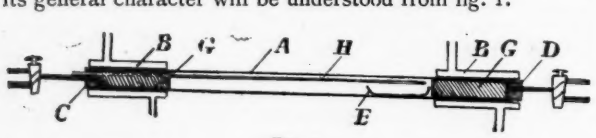


Fig. 1.

A is a quartz tube (24 in. long by 1 in. diameter) heated by means of a Fletcher furnace. The ends of the tube projected beyond the furnace; and the rubber corks C and D were cooled by water-jackets B. The coal was placed in a thin fire-clay boat E. In order that the gaseous products might be quickly removed from the hot part of the tube, loosely-fitting fire-clay stoppers G and G were placed in the positions shown. Through the cork C and the stopper G, and along the inside of the tube, passed a quartz sheath H. By sliding a thermocouple inside this, the temperature of any part of the tube could be noted at any time during the experiment.

A glass capillary tube, connected with a three-way tap, passed through each of the corks C and D; so that connections could be made as desired to (1) a vacuum pump and manometer, (2) a supply of purified nitrogen for sweeping out the air from the tube [in experiments Nos. 1 and 2 ordinary coal gas was used for the purpose.], (3) a gasholder for collecting and measuring the gas evolved, and (4) a tube for drawing off samples of gas from time to time.

The tube was packed with hard coke (crushed to pass through a $\frac{1}{4}$-inch and over an $\frac{1}{8}$-inch mesh) between the boat E and stopper G. The results of experiment No. 1 show the composition of the gas evolved during different stages of the distillation.

The tube was heated to a temperature of 800° C.; air being expelled by means of a stream of coal gas. Then the cork D and stopper G were removed; the boat E, containing 3 grammes of coal, was inserted; the stopper and cork quickly replaced; and the stream of coal gas stopped. Gas was rapidly evolved from the coal; and in this experiment it was drawn off at the right-hand end of the tube, so that it was subjected to a minimum amount of heat action. Samples of gas were collected over glycerol and water (previously saturated with coal gas) from time to time; and the analyses are given in the following table:

TABLE I.—*Experiment No.* 1.

| Time from Start in Minutes. | 1. | 8. | 15. | 30–36. |
|---|---|---|---|---|
| Unsaturated hydrocarbons | 15·3 | 0·4 | *nil* | — |
| Methane | 57·5 | 14·5 | 5·8 | 4·6 |
| Hydrogen | 12·4 | 67·8 | 67·8 | 63·1 |
| Carbon monoxide | 5·4 | 12·2 | 18·3 | 24·5 |
| Carbon dioxide | 5·6 | 2·5 | 2·9 | 2·4 |
| Oxygen | *nil* | 0·1 | 0·1 | — |
| Nitrogen | 3·8 | 2·5 | 5·1 | 5·4 |

It is interesting to compare with these figures some results obtained by Dr. Harold G. Colman in the carbonization of six-hour charges in horizontal retorts at 950° C. The following table gives the composition of the gas evolved at various stages:

TABLE II.

| Hours after Commencement. | ½. | 1½. | 2½. | 3½. | 5. |
|---|---|---|---|---|---|
| Sulphuretted hydrogen | 3·8 | 3·1 | 2·8 | 2·1 | 1·2 |
| Carbon dioxide | 3·0 | 2·8 | 2·6 | 2·3 | 1·7 |
| Unsaturated hydrocarbons | 8·7 | 5·2 | 3·6 | 2·4 | 0 |
| Oxygen | 0 | 0 | 0 | 0 | trace |
| Carbon monoxide | 4·3 | 5·0 | 4·9 | 4·5 | 3·8 |
| Hydrogen | 29·8 | 37·5 | 42·2 | 46·2 | 60·8 |
| Methane | 40·7 | 42·0 | 39·4 | 37·5 | 26·3 |
| Nitrogen | 0·7 | 4·4 | 4·5 | 5·0 | 6·2 |

It will be seen that the changes in composition are of the same kind as we obtained in our experiment; but in a large-scale process there is at any period coal in various stages of carbonization, and thus the fractions of gas are mixed to a considerable extent before leaving the retort.

Experiment No. 2 was conducted in an exactly similar manner to experiment No. 1, except that the samples of gas were taken off at the left-hand end of the tube. Thus the volatile products had to pass through the column of coke 36 cm. long maintained at a temperature of 800° C. The following is an analysis of a sample taken 1 minute after introducing the coal into the hot tube:—

| | |
|---|---|
| Experiment No. | 2 |
| *Unsaturated hydrocarbons | 3·2 |
| Methane | 35·0 |
| Hydrogen | 43·9 |
| Carbon monoxide | 14·9 |
| Carbon dioxide | 1·0 |
| Oxygen | 0·3 |
| Nitrogen | 1·7 |

* Estimated by absorption in water half saturated with bromine.

On comparison with the corresponding sample obtained in experiment No. 1, it will be seen that there has been a considerable decomposition of hydrocarbons in passing over the hot coke.

In experiments Nos. 3 to 5 (the results of which are duly

summarized in Table III.), all the gas as evolved from the coal was passed into the holder, so that its volume could be noted and an analysis of the mean sample obtained. The temperature of that part of the tube in which the boat containing coal was placed was maintained at 850° C., and the rest of the tube at 800° C. Air was displaced by means of nitrogen before introducing the coal, and then the distillation was continued for one hour, after which it was found that the rate of evolution of gas was only about 0·25 c.c. per gramme of coal per minute.

TABLE III.—*Experiments Using Coal.*

| — | Hot Coke Surface. | | Radiant Heat. | | Minimum Heat Action. | |
|---|---|---|---|---|---|---|
| Experiment No. | 3 | 3A | 4 | 4A | 5 | 5A |
| Free space in tube, c.c.. . | 140 | 140 | 240 | 240 | — | — |
| Wt. of coal taken, grammes | 2 | 2 | 3·5 | 3·5 | 2 | 2 |
| Vol. of gas obtained in c.c.. | 765 | 770 | 1216 | 1220 | 636 | *(588) |
| Gas per ton of coal, cub. ft. | 13,700 | 13,800 | 12,500 | 12,500 | 11,400 | — |
| *Percentage Composition of Gas (Nitrogen Free).* | | | | | | |
| Unsaturated hydrocarbons. | 2·3 | 3·3 | 4·6 | 5·0 | 5·3 | 6·3 |
| Methane . . . . . | 27·5 | 27·3 | 31·0 | 30·9 | 31·5 | 33·1 |
| Hydrogen . . . . . | 49·5 | 51·2 | 46·6 | 46·6 | 41·6 | 42·5 |
| Carbon monoxide . . . | 16·1 | 14·7 | 14·3 | 13·3 | 16·1 | 13·1 |
| Carbon dioxide . . . . | 4 1 | 3·2 | 3·4 | 3·2 | 4·4 | 4·3 |
| Oxygen. . . . . | 0·5 | 0·3 | 0·1 | 1·0 | 0·9 | 0·7 |
| *Actual Volumes in c.c. per Gramme of Coal.* | | | | | | |
| Unsaturated hydrocarbons . | 8 0 | 11·9 | 14·6 | 15·7 | 15·0 | 17·1 |
| Methane . . . . . | 98 | 100 | 99 | 96 | 88 | *(90) |
| Hydrogen . . . . . | 176 | 187 | 149 | 146 | 117 | *(116) |
| Carbon monoxide . . . | 57 | 54 | 45 | 41 | 45 | *(35) |

* Last fraction of the gas was lost.

The unsaturated hydrocarbons were estimated by absorption in water half saturated with bromine. The oxygen in the gas is presumably due to the little air which finds its way into the apparatus when the coal is introduced.

Experiment No. 3 was carried out in a similar manner to No. 2 except that only 2 grammes of coal were taken, and the whole of the gas was passed through the hot-coke column into the holder. In experiment No. 4, the coke was removed from the tube, so that the influence of radiant heat from the walls of the tube might be noted by collecting the gases after they had passed through the hot, but empty, tube.

It should be noted that surface action on the gas cannot be entirely eliminated, owing to the necessity for some containing vessel, but it is possible to make two comparative experiments in one of which the surface exposed to the gas is relatively very small. On the assumption that each piece of coke is a smooth sphere, we have calculated that the ratio of surface exposed to the gas when the tube is packed with coke to the surface of the tube itself is 8 : 1. But owing to the irregularity of the coke particles, the actual ratio must be enormously greater.

In order that the time during which the volatile products are heated may be approximately the same in the two experiments, some adjustment must be made for the difference in the free space in the tube when packed and unpacked. This free space was estimated by measuring the volume of water which could be run into the tube in the two cases, and the weight of coal taken was roughly proportional to the free space. The analytical results are set out in Table III.

In experiment No. 4 (radiant heat), a very thick tar was deposited on the cool ends of the tube and in the capillary exit tube; also there were large carbon deposits on the fire-clay stopper at the exit end, which suggest that much decomposition had occurred in the main body of the gas, quite apart from any occurring on the surface of the tube itself. In the experiment with the packed tube very little tar survived the action of the coke surface, and all the free carbon seemed to be filtered out by the coke before the gas reached the end of the tube. The coke packing was dulled and blackened.

In experiment No. 5, the gas was drawn off at the right-hand end of the tube, so that it should be subjected to a minimum amount of heat action. In order to minimize the diffusion backwards of gases and vapours, the free space of the tube was closely packed with powdered ignited fire-clay. As might be expected, the tar formed in this experiment was much thinner than in the previous experiment when the gas was passed through the hot empty tube.

It was next thought desirable to see how far it was possible to reproduce the results that had been obtained, and accordingly experiments Nos. 3, 4, and 5 were repeated. The results of the six experiments have been tabulated for comparison in Table III.

### Results of Experiments on Coal.

It will be seen that the result of subjecting the immediate products of distillation to the action of radiant heat in the unpacked tube (experiments Nos. 4 and 4A) was an increased yield of gas equivalent to 1100 cubic feet per ton of coal, the comparison being made with experiments (Nos. 5 and 5A) in which the products were removed as quickly as possible from the hot part of the tube. It was also evident from the results, that by passing the products through a column of hot coke a further increase in the volume of gas was obtained equivalent to 1250 cubic feet per ton. It should be noted that these increased volumes of gas were obtained without heating the coal or coke above 800° C. The gas analyses show that the influence of the heat has been felt most by the unsaturated hydrocarbons, and that there has been a marked increase in the volume of hydrogen. It should be noted that this extra hydrogen is not obtained at the expense of the methane, but is most probably a product of the decomposition of the higher hydrocarbon vapours and tarry matter generally. It will be shown later that the decomposition of methane under gas-retort conditions is only appreciable when temperatures higher than 800° C. are reached.

### Ammonia Yield.

A separate series of experiments was carried out to determine the yield of ammonia under the several conditions of experiments Nos. 3, 4, and 5. The gases evolved from the coal were bubbled through dilute sulphuric acid, and at the end of the distillation the delivery tube was washed out and the liquor and washings were distilled with caustic soda; the ammonia being estimated in the usual way. Great care had to be taken that no condensation of liquor took place at the cool ends of the tube or on the fire-clay stoppers. All experiments at the end of which these were not found to be quite dry were discarded. The distillation temperature was maintained at 800° C.; and that part of the tube in which the boat is placed was heated to about 860° C. just before introducing the boat, so as to ensure a more rapid heating of the coal to 800° C.

In experiment No. 6, 2 grammes of coal were taken, and the volatile products passed through the hot coke bed as in experiment No. 3—10·1 per cent. of the nitrogen in the coal being recovered as ammonia. This was repeated, and experiment No. 6A gave 8·7 per cent. In experiment No. 7 the volatile products from 3½ grammes of coal were passed through the hot empty tube as in experiment No. 4. Of the nitrogen 18·2 per cent. was recovered as ammonia. Experiment No. 7A gave 16·2 per cent.

The arrangement used in experiment No. 5, in which the gases were withdrawn before they had been subjected to thermal decomposition, was not found to be suitable for the estimation of ammonia, owing to the condensation of moisture in the fire-clay at the cold end of the tube. A special silica retort was therefore obtained (see fig. 2).

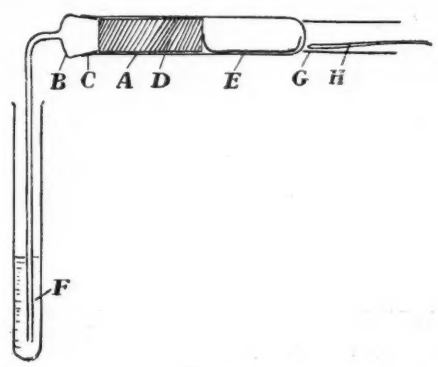


Fig. 2.

A is the retort (1 inch diameter, 6 inches long) closed at one end, and with a mouthpiece and delivery tube B fitting

with a ground joint, as shown at C. D is the fire-clay plug and E the boat as used in the previous apparatus. No water-jacket was necessary in this case, as there was no rubber joint to protect. To estimate the temperature to which the retort was heated, another tube G of similar thickness was placed in the position shown. The temperature to which this was heated (800° C.) was measured by a thermocouple H. The two tubes A and G were heated in the same furnace, and the flames adjusted so that they appeared to be heated to the same degree of redness. The volatile products passed down the delivery tube and through dilute sulphuric acid in F, as shown. Three grammes of coal were taken for each distillation, and in three experiments (Nos. 8, 8A, and 8B), 22·1 per cent., 25·1 per cent., and 20·2 per cent., of the total nitrogen was recovered as ammonia. Summarizing:

| | | | |
|---|---|---|---|
| Mean of expts. 8, 8A, & 8B | (minimum heat action) | 22·5 per cent. of $N_2$ as $NH_3$ | |
| ,, ,, ,, 7 & 7A | (radiant heat) | 17·2 ,, ,, ,, ,, | |
| ,, ,, ,, 6 & 6A | (hot coke surface) | 9·4 ,, ,, ,, ,, | |

The extent of the decomposition of ammonia by heat may be seen from the above summary. It will be observed that the agreement between the several experiments of the same kind is not good. We are of the opinion that this is mainly due to slight differences in the carbonizing conditions—*e.g.*, rate at which the coal was raised in temperature. To have obtained more concordant results would have demanded the expenditure of more time than we felt justified in giving at this stage. We hope to examine the decomposition of ammonia in further detail at some future date.

### Hydrocyanic Acid.

After the absorption of ammonia in experiments Nos. 6, 6A, 7, and 7A, the gas was passed through caustic potash solution for the absorption of hydrocyanic acid. The solution thus obtained, after acidification and addition of lead nitrate solution, was distilled; any hydrocyanic acid evolved being absorbed in caustic potash. Sulphur was precipitated from this solution by means of lead carbonate, and was filtered off; the filtrate being titrated with decinormal silver nitrate solution after the addition of potassium iodide. In no case could the presence of any hydrocyanic acid be detected. Carpenter and Linder [Forty-Fifth and Forty-Sixth Annual Reports on Alkali, &c., Works] found that high temperatures and prolonged heating of the gas stream favour the formation of cyanogen under the conditions existing in carbonization.

### Experiments on Flowing Gases.

After these experiments we turned our attention to the behaviour of individual volatile products of carbonization. The most important work that has been done on the pyrogenic decomposition of hydrocarbons has been mainly directed towards the determination of either the equilibria in various gaseous systems, or else the exact mechanism of certain hydrocarbon decompositions. As an example of the former may be quoted the research of Mayer and Altmayer ["Berichte," 1907 (2), 2134] on the equilibrium $CH_4 \rightleftarrows C + 2H_2$. The results obtained experimentally and by calculation in this manner have very little bearing on the decomposition of methane under gas-retort conditions, because of the time required to attain equilibrium, and the same limitation attaches to the value for practical purposes of many other equilibrium determinations.

What is known regarding the mode of decomposition of hydrocarbons is of great scientific importance; but the various workers in this field have confined their attention for the most part to the behaviour of pure hydrocarbons, and have not determined the influence of other substances present upon the ultimate yield of the various decomposition products. The influence of hydrogen and methane on the decomposition of any hydrocarbon cannot be disregarded when these gases are present to the extent to which they are found in coal gas. Moreover, it is very regrettable that in many cases no record has been made of the time during which the gas under examination was heated, thus making it impossible to estimate the rate of any reaction. In some instances even the temperature has been very imperfectly recorded.

The problem, therefore, to which we addressed ourselves was to determine the nature and the amount of decomposition suffered by the volatile products of carbonization under conditions of temperature and time of heating comparable with those which exist in large-scale carbonizing processes such as in gas-retorts and coke-ovens. The time during which the volatile products are heated varies considerably at different stages, and under different conditions of carbonization. With horizontal retorts and heavy charges it probably averages 1½ to 2 minutes during the first half of the carbonizing period.

Simmersbach ["Stahl und Eisen," 1913, 33, 239] deduced that with producer gas, or with a mixture of coke-oven gas and blast-furnace gas, there is a loss in calorific value in the regenerators of steel furnaces which is only partially counterbalanced by the increased volume of gas resulting from the decomposition of hydrocarbons. The carbon dioxide, oxygen, unsaturated hydrocarbons, and some methane disappear; while the percentages of carbon monoxide, hydrogen, and nitrogen are increased. A similar result is obtained when coal gas is passed over hot coke in the making of light gas for balloons. [Oechelhauser "Gas World," 1914, 142.]

### Synthesizing Coal Gas.

The scheme of our research was to take a mixture of equal parts of hydrogen and methane as the basis, and after noting the influence of heat on this mixture to add to it small percentages of other hydrocarbons. [Complications arising from the presence of oxygen in any form have been excluded as far as possible for the present.] Temperatures of 800° C. and 1100° C. have been the only ones at which the decompositions have as yet been studied, and only experiments in which the gases were passed through a tube packed with coke are here recorded.

### The Apparatus Used in the Experiments with Flowing Gases.

The gases are mixed as desired in a 5-litre holder, and stored over glycerine and water. The gas mixture then passes through a very fine capillary tube connected with a differential manometer, so that the rate of flow can be noted and controlled. This is followed by a wash-bottle containing an alkaline solution of pyrogallic acid and a calcium chloride tube to free the gas from any traces of oxygen and moisture.

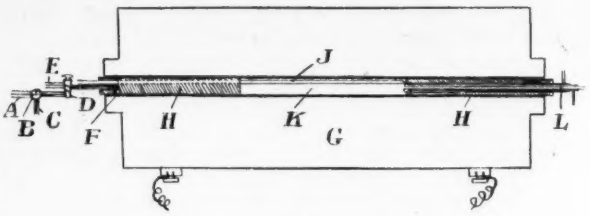


Fig. 3.

The calcium chloride tube is connected to the three-way tap B (fig. 3), so that a sample of gas as it enters the furnace tube can be taken through C. [The samples are preferably taken over mercury]. Connection is made with the furnace tube F through the tap D, so that either the gas mixture can be admitted through A, or pure dry nitrogen may be passed into the tube through E. F is the porcelain tube heated by means of the electric furnace G. The ends of the tube are packed with fireclay stoppers H, and the temperature is measured by means of a thermocouple inside the sheath J. [It will be seen that the apparatus resembles in many respects that used in the first series of experiments—fig. 1.]

The centre portion K of the tube F may be left empty or packed with coke as desired. The length of this portion is 24·5 cm., and the free space when it is packed with coke is estimated at 40 c.c. In order that the gases may be rapidly cooled from the experimental temperature to that of the atmosphere, they are removed from the hot zone of the furnace through a water-cooled copper sampling tube L. The gas is then passed through a glass spiral maintained, by means of a solution of ammonium nitrate in water, at a temperature of 5° C., to condense any liquid products of the decomposition of hydrocarbons. This is followed by a sampling tube and a gasholder, in which the gas is collected and measured. Also a three-way tap enables connection to be made with a pump whenever it is desired to evacuate the spiral and tube F.

The rate at which the gas flows through the apparatus (as indicated by the differential manometer) is controlled by the rate at which the glycerine and water mixture is run off from the gasholder at the end of the train of apparatus.

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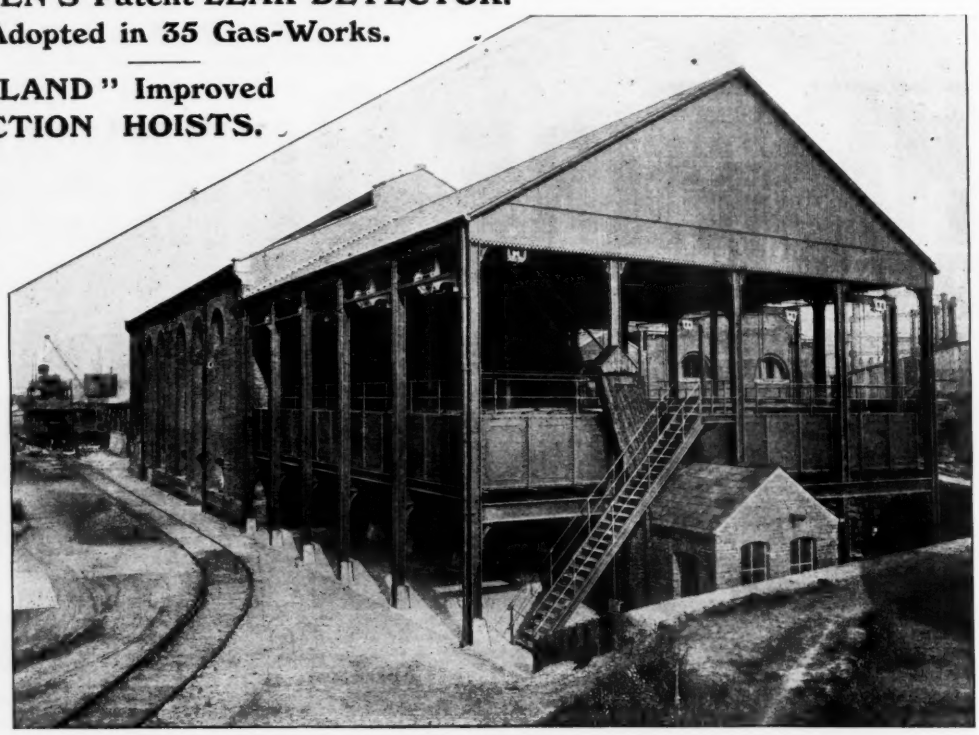

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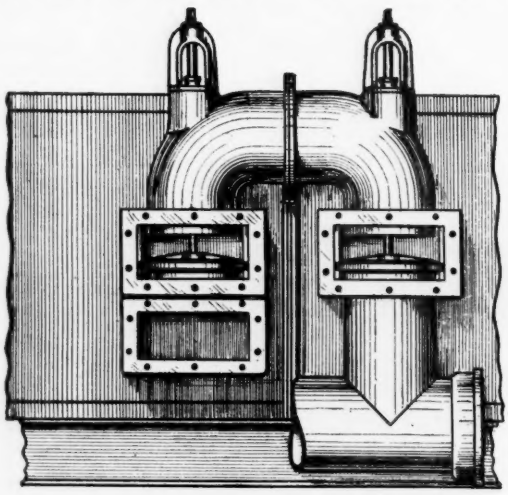
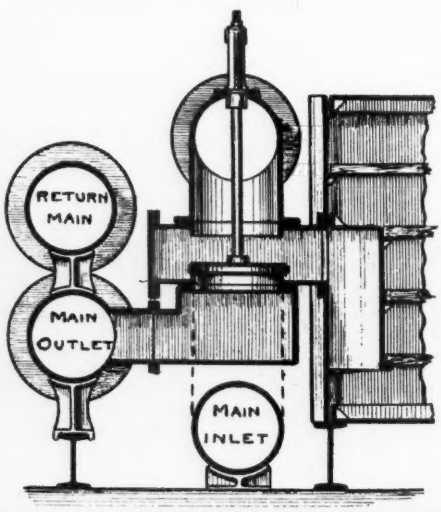




Thus the whole apparatus is under a few inches pressure while the stream of gas is passing. The coke with which the space K is packed was prepared in the laboratory from the New Hucknell coal. It was found necessary to heat this at 1100° C. for some considerable time to complete the evolution of small quantities of gas (mainly hydrogen and carbon monoxide), and also to heat it in a current of hydrogen to reduce the oxides in the ash. [An appreciable quantity of sulphuretted hydrogen was evolved.]

### The Decomposition of Methane.

Bone and Coward ["J. C. S.," 1908, 93, 1197] concluded that methane decomposes chiefly directly into carbon and hydrogen, the process being reversible, and a surface phenomenon at least up to 1200° C. Simmersbach [*loc. cit.*] found that the decomposition of pure methane was very rapid above 900° C., and was completed in 90 seconds at 1100° C. Mayer and Altmayer deduced that methane hydrogen mixtures when in equilibrium above 800° C. contain very small quantities of methane. The methane used in our experiments was prepared from aluminium carbide and purified by passing through (1) an alkaline solution of pyrogallic acid, (2) a solution of potassium permanganate, (3) an ammoniacal solution of cuprous chloride, and (4) dilute sulphuric acid. The methane thus purified contained some hydrogen, and more hydrogen was added from a cylinder until the mixture contained 50 per cent.

In experiment No. 9, this mixture was passed through the furnace heated to 800° C. [The temperatures recorded are maximum temperatures; the mean temperature of the coke column is a few degrees less than the maximum.] As the gas collected in the holder after the furnace contains more nitrogen than the gas entering the furnace, due to the nitrogen in the apparatus at the commencement of an experiment, all gas analyses are calculated on a nitrogen-free gas. Also the gas leaving the tube always contained small quantities of oxides of carbon. These were larger than would result from the trace of oxygen sometimes found in the entering gas, and we attribute them to the slow reduction of oxides in the coke ash. In the following statements of results they have been regarded as nitrogen. Below are given the details of two experiments.

*Mixture of Hydrogen and Methane. Temp.* 800° *C.*

| | | | |
|---|---|---|---|
| Experiment No. | | 9 | 9A |
| Vol. of mixture passed through tube, c.c. | | 1230 | 1260 |
| Duration of heating, seconds | | 58 | 57 |
| Gas entering tube | methane | 50·9 | 53·2 |
| | hydrogen | 49·1 | 46·8 |
| Gas leaving tube | methane | 49·5 | 52·5 |
| | hydrogen | 50·5 | 47·5 |
| Percentage of methane decomposed | | 2 | |

Thus it will be seen that at 800° C. only about 2 per cent. of the methane is decomposed in one minute, although the quantity of methane present is considerably in excess of the equilibrium ratio. Experiments Nos. 10 and 10A show the decomposition of methane at 1100° C.

*Mixture of Hydrogen and Methane. Temp.* 1100° *C.*

| | | | |
|---|---|---|---|
| Experiment No. | | 10 | 10A |
| Vol. of mixture passed through tube, c.c. | | 1230 | 1280 |
| Duration of heating, seconds | | 47 | 46 |
| Gas entering tube | methane | 50·9 | 53·2 |
| | hydrogen | 49·1 | 46·8 |
| Gas leaving tube | methane | 6·6 | 7·6 |
| | hydrogen | 93·4 | 92·4 |
| Percentage of methane decomposed | | 65 | |

The decomposition of methane is very rapid at 1100° C., as the above shows. As a result of the decomposition there was an increase in volume of about 44 per cent.; but there is a considerable loss of potential heat or calorific value, as the carbon of the decomposed methane is lost so far as the gas is concerned.

### Decomposition of Ethane.

Bone and Coward concluded that the decomposition of ethane is not chiefly a surface effect, but takes place throughout the main body of the gas. They put forward the hypothesis that the primary effect of heat is to cause elimination of hydrogen with a simultaneous loosening or dissolution (according to temperature) of the bond between the two carbon atoms. In the event of dissolution, there would arise an unsaturated residue $:CH_2$, which has a very fugitive separate existence in the decomposing medium.

J. J. Thomson ["Chemical News," 1911, 103, 265] has shown that such residues as $:CH$, $:CH_2$, and $\cdot CH_3$ may exist momentarily in a free state. The three possibilities open to the residue $:CH_2$ are: (1) To form ethylene by contact with another similar residue; (2) to break-down into carbon and hydrogen; (3) to be hydrogenized to methane in an atmosphere already rich in hydrogen.

The ethane used in our experiments was prepared by the slow electrolysis of a concentrated solution of potassium acetate and purified in a similar manner to methane to free from carbon dioxide, oxygen, and acetylene. The purified gas was added to the hydrogen methane mixture and the decomposition first studied at 800° C.

*Mixture of Hydrogen, Methane, and Ethane. Temp.* 800° *C.*

| | | |
|---|---|---|
| Experiment No. | | 11 |
| Volume of mixture passed through tube, c.c. | | 1510 |
| Duration of heating, seconds | | 46 |
| | Gas Entering Tube. | Gas Leaving Tube. |
| Ethane | 4·2 | 0·9* |
| Methane | 47·5 | 48·9 |
| Hydrogen | 48·3 | 48·9 |
| Ethylene | — | 1·3 |
| Acetylene | — | Trace |
| Percentage of ethane decomposed | | 79 |

* It should be noted that the accurate estimation of small percentages of ethane in the presence of a large quantity of methane presents some experimental difficulty.

In this and other cases where it was desired to estimate ethane, the hydrogen was estimated by absorption in colloidal palladium [see Appendix], and the methane and ethane by explosion analysis. Ethylene is estimated by absorption in water half saturated with bromine, and acetylene by absorption in a saturated solution of silver chloride in concentrated ammonia.

The decomposition of ethane under these conditions is rapid, but not complete in 46 seconds, at 800° C. The chief products of the decomposition are ethylene and methane, as might be predicted from Bone and Coward's hypothesis. No condensation was noticed in the spiral; but probably the volume of gas passed through the tube was too small for the detection of liquid or solid products.

The next experiment was with ethane at 1100° C.; and the decomposition, which had been found to be very extensive at 800° C., was more so at 1100° C.—88 per cent. of the ethane being decomposed.

### Decomposition of Ethylene.

As in the case of ethane, Bone and Coward suppose that the primary action of heat is to eliminate hydrogen, which is again not chiefly a surface action. The residue $:CH$ thus formed may decompose or be hydrogenized to methane, or it may unite with another such residue to form acetylene. Simmersbach found that the decomposition of pure ethylene became very rapid above 600° C., and at 900° C. was almost complete in about one minute.

The ethylene we used in our experiments was prepared by the action of concentrated sulphuric acid on alcohol, and purified by liquefaction and fractional distillation. The following results show that at 800° C. the decomposition is by no means complete in 45 seconds.

*Mixture of Hydrogen, Methane, and Ethylene. Temp.* 800° C.

| | | |
|---|---|---|
| Experiment No. | | 12 |
| Volume of mixture passed into tube, c.c. | | 1780 |
| Volume of gas collected after passing through tube, c.c. | | 1625 |
| Contraction, per cent. | | 8·6 |
| Duration of heating, seconds | | 45 |
| | Gas Entering Tube. | Gas Leaving Tube. |
| Ethylene | 10·6 | 4·5 |
| Methane | 47·7 | 54·4 |
| Hydrogen | 41·7 | 40·3 |
| Benzene | — | — |
| Acetylene | — | 0·8 |
| Ethane | — | *Nil* |
| Percentage of ethylene decomposed | | 62 |

Thus in this case the chief products are methane and acetylene. The contraction in volume may be due to the formation of methane, or of some liquid or solid product which, if formed, was too small in bulk to be detected. A similar mixture was next heated at 1100° C.

*Mixture of Hydrogen, Methane, and Ethylene. Temp.* 1100° *C.*

| | | |
|---|---|---|
| Experiment No. | | 13 |
| Volume of mixture passed into tube, c.c. | | 2240 |
| Volume of gas collected after passing through tube, c.c. | | 2830 |
| Expansion (net), per cent. | | 26 |
| Duration of heating, seconds | | 35 |
| | Gas Entering Tube. | Gas Leaving Tube. |
| Ethylene | 9·6 | *Nil.* |
| Methane | 44·7 | 18·6 |
| Hydrogen | 45·7 | 81·4 |
| Benzene | — | *Nil.* |
| Acetylene | — | Trace. |

Heating for 35 seconds completed the decomposition of

the ethylene; the only gaseous products being methane and hydrogen.

### Decomposition of Benzene.

The action of heat on benzene has been studied by many chemists, but in most cases with special reference to the nature of the higher hydrocarbons formed. Very imperfect records have been made of the temperature and duration of heating. Haber and Oechelhauser ["Journal für Gasbeleuchtung," XXXIX., 813] found that benzene was practically unchanged after a few seconds' heating at 900° C., but that it decomposes between 900° and 1000° C., forming higher aromatic compounds.

The benzene used in our experiments was purified by fractional distillation and recrystallization until it had a constant boiling point.

The benzene was introduced to the gas stream by passing the hydrogen methane mixture at a constant rate through the liquid benzene maintained at a constant temperature of 10° C., and then through the calcium chloride tube, which filtered-out any spray carried forward. In this way 5 per cent. of benzene was added to the gas. In experiment No. 14 the mixture was heated 51 seconds at 800° C. There was found in the gas leaving the furnace 4·3 per cent. of benzene,* and some liquid was condensed in the spiral condenser. This solidified almost completely at 5° C., and was assumed to be benzene. When weighed, it was found to be equivalent to the amount of benzene removed from the gas. [Gas saturated at 5° C. contains about 4·3 per cent. of benzene vapour.] We therefore concluded that the decomposition of benzene at 800° C. was negligible.

A very different result was obtained at 1100° C., as the following table shows:—

*Mixture of Hydrogen, Methane, and Benzene. Temp.* 1100° *C.*

| | |
|---|---|
| Experiment No. | 14 |
| Volume of mixture passed into tube, c.c. | 1760 |
| Volume of gas collected after passing through tube, c.c. | 2510 |
| Duration of heating, seconds | 42 |

* Estimated by absorption in ordinary pure concentrated sulphuric acid, density 1·84.

| | Gas Entering Tube. | | Gas Leaving Tube |
|---|---|---|---|
| Benzene | 5·0 | .. | *Nil.* |
| Methane | 47·8 | .. | 11·1 |
| Hydrogen | 47·2 | .. | 88·4 |
| Ethylene | — | .. | *Nil.* |
| Acetylene | — | .. | Trace. |
| Ethane | — | .. | Trace (?) |

No trace of benzene could be detected after heating the mixture at 1100° C. The solid and liquid products, if formed, were too small in bulk to be detected.

### Conclusion.

It will be plain from this account of the experiments we have so far made that this study is only in its first stage, particularly since, except in the somewhat rough preliminary experiments made on the whole of the gaseous products from coal, we have only obtained results for the influence of red-hot coke. The experiments are being continued on the action of radiant heat, and on the decomposition of such substances as the higher hydrocarbons of ammonia and of gases containing oxygen, which has so far been an excluded element.

### APPENDIX.

After several failures, the method we adopted for the estimation of hydrogen by absorption in colloidal palladium was: The colloidal palladium solution (containing sodium picrate) was placed above the surface of mercury in a modified Hempel pipette, which was fitted with taps and a levelling pipette, so that the pressure can be adjusted to that of the atmosphere as the absorption of hydrogen proceeds. The solution has to be first saturated with methane and ethane. Hence the necessity for maintaining a fairly constant pressure in the pipette. The gas containing hydrogen, nitrogen, and paraffins, after the removal of other constituents by absorption, is passed into the pipette from the Bone and Wheeler apparatus and shaken vigorously for at least twenty minutes. The method cannot be regarded as completely satisfactory, as the solution becomes much slower in its action after keeping some time.

# THE LECTURE.

## PURIFICATION BY HEAT: A CENTURY'S PROGRESS AND ITS LESSONS.

By CHARLES C. CARPENTER, D.Sc., M.Inst.C.E.

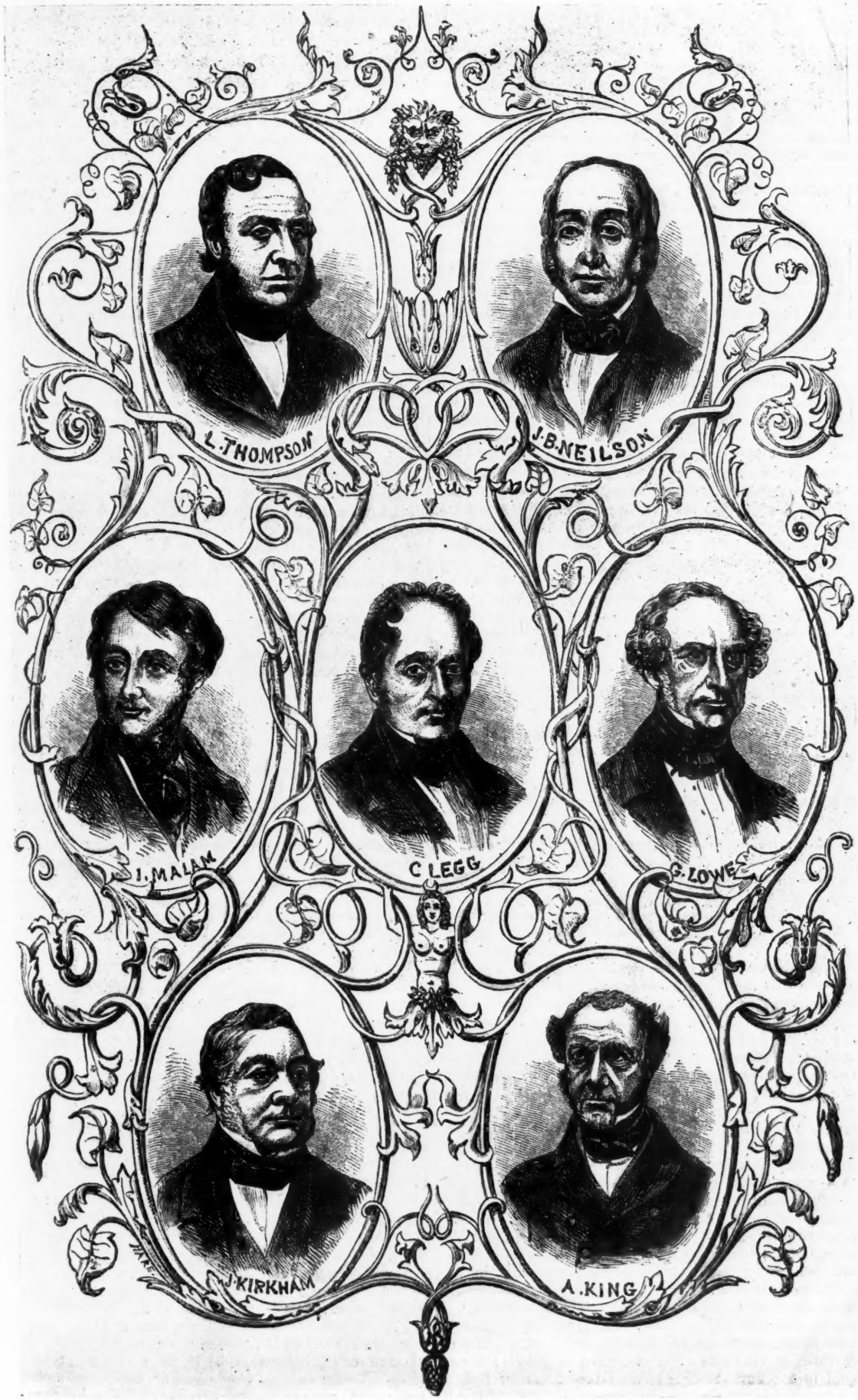
### Introduction.

My first duty to-day must be to express my deep appreciation of the honour your Council has conferred on me in inviting me to occupy a position which has in the past been filled by so many distinguished men. I must dwell this morning upon some of their work, recall to your minds some of their teachings—not as a prophet pressing upon unwilling ears his fantastic beliefs, but as a dreamer seeking to attune them to the keynote furnished by success. This could not be offered as an apology for my *rôle* to-day were its title merely "A Century of Purification by Heat." One of your Past-Presidents, Mr. Doig Gibb, with the experience gained by the staff he controls, would have dealt admirably with the engineering aspect of such a question. His assistant in the same Company, Mr. Evans, would have expounded the chemical bearings of the problem with the knowledge born of eight years' patient study. And we might even bring in a third party, Mr. Goodenough, who would tell you to what extent his sales of gas produced by the largest Company in the world would be affected, when the products of combustion consist wholly of carbonic acid and water. My lecture has, however, a sub-title to its primary one; and it is because I want to deal not only with the century's progress but its lessons, that I am here to-day, poaching, if you will, upon the preserves of the three gentlemen I have named (to say nothing of many others), because my licence to shoot is quite free from those restrictions with which they may be blessed or hampered as the case may be.

### Early Work in Purification by Heat.

It is a significant circumstance that while but yesterday we were celebrating the centenary of gas lighting, we can to-day celebrate the centenary of its purification by heat. Yet so it is. Probably the fascination which the alembic and the furnace exercised over the votaries practising those arts which have their foundation in distillation, accounts for the fact that, as far back as 1806, Edward Heard, who two years earlier had been an assistant of Winsor, patented the first proposal for the purification of gas by heat; the object being to obtain gas in such a state that it might be "burned without producing any offensive smell." His idea seems to have been a dual one. In the first place he proposed to add alkalies or alkaline earths to the coal in the retort, and distil both together. This comes very near to those autogenous processes of which the most important is that known as Cooper's, recently successfully revived by Paterson. His second suggestion was to pass the crude gas over alkaline earths or certain metals or their oxides, previously aid in an iron tube or other vessel, and then exposed to the heat of a furnace.

We may thus regard Heard as the common father of purification by heat. Winsor not only employed him to perform his experiments, but entrusted him with the manuscript of his lectures—a confidence he had occasion to regret one night, when a crowded audience left the theatre after waiting an hour-and-a-half for Heard, who, with the lecture in his pocket, had been dining with some friends, "not wisely but too well," in a neighbouring tavern. It was probably his apparatus, or something like it, which was referred to by a Director of the Horsley Iron-Works at Tipton, named Manby, who, writing to the "Philosophical Magazine" in 1818, stated that he had been for several years engaged in the manufacture of apparatus for this purpose, and fitting them up in various parts of the country. His letter was in reply to an editorial notice in the same journal upon patents taken out by George Palmer, then of the




Reproduction of the Frontispiece to Vol. 2 (1851-52) of the "Journal"—*Referred to in the Carpenter Lecture.*

Chartered Gas Light and Coke Company, and afterwards the first Engineer of the South Metropolitan Gas Company, for whom he constructed the original works on three acres of ground alongside the Surrey Canal. His process was one for passing the crude coal gas through heated tubes containing iron, oxide of iron, or ironstone, so disposed as to present as large a surface as possible. Gas thus treated he says "affords no disagreeable odour during combustion." Lowe, too, did a similar thing, using iron turnings in the secondary retort; and it is interesting to record the fact that in the same year, in this very City of Liverpool which shares with the Metropolis so much of the honour connected with the early development of gas lighting, Samuel Parker employed, not oxidizable substances, but an arrangement of horizontal iron pipes heated in a furnace. Palmer's process was referred to by Peckston in 1819 as working on a small scale at Macclesfield.

That sulphur in purified coal gas probably existed as bisulphide of carbon was first pointed out in the year 1820 by Brande, who believed he often smelt it when gas escaped during repairs from pipes opened in the streets. I think he must have had a sixth sense for its presence, as some ladies have for spiders. To prove, among other things, whether gas made in those days had any differing characteristics, including odour, from the present, I had a full-size iron retort cast from an old one the Phœnix Company used before adopting clay. It was worked at a temperature to give about 8000 cubic feet of gas per ton from best Durham coal. But though the sulphur content was much lower than to-day, no difference in smell was perceptible. Brande at the same time stated that Palmer's process could not succeed owing to the deposition of carbon and the consequent loss of illuminating power. Four years later he gave evidence in favour of oil as a substitute for coal in the inquiry as to whether Westminster was to be lighted by oil gas or coal gas—laying great stress on the immunity of the former from sulphurous combustion products. On the other hand, Faraday affirmed that sulphuret of carbon (as it was then called) had never been proved to exist in purified coal gas; and neither Cooper nor Dalton was able to detect its presence.

### Introduction of Testing for Sulphur.

Purification by heat had certainly not passed out of knowledge ten years later, for Mathews in 1832 refers very fully to the proposals of Palmer and others. But they cannot have come into very general use; for in 1842 we have the well-known instance of the library at the Athenæum Club, and the appointment of a Committee, in which were included Faraday and Brande, to investigate the complaint of damage to books. The Committee, it may be remembered, reported that this was caused by the excessive sulphur content in the products of gas combustion for which no ventilation had been provided.

In 1851, the Great Central Gas Consumers' Act was passed, by which the Lord Mayor and Court of Common Council were empowered to appoint a chemist to test the gas supplied. The following year they selected Dr. Henry Letheby for the post; and from this appointment originated what came to be known as the "sulphur bugbear." Letheby's first report spoke only about the purity of the supply being exemplified by the absence of ammonia and sulphuretted hydrogen; and for this he was called to account by Lewis Thompson, who pointed out that the Great Central gas gave a very handsome crop of potassium xanthate crystals, while the City gas gave little or none. The inference Thompson drew as to the cause of the difference was probably the correct one—namely, that the Engineers of the newer Company were working with higher heats. Letheby's second report, issued in the autumn of 1852, certainly makes amends for his omission; for he states that the gas had on several occasions been overcharged with bisulphuret of carbon. In his third report, issued at the close of the same year, he is still more emphatic; for, in speaking of the elimination of the sulphur compounds, he says: "It is highly desirable that some means should be taken to ensure a more perfect manufacture of coal gas . . . when it may then be employed to any extent either as a source of heat or light; and it is not too much to hope that the time is not far distant when its application will entirely supersede the use of coal, and so be the means of rendering the atmosphere of this Metropolis as free from smoke and soot as that of any city in the world."

### Gas Companies and the Sulphur Problem.

Surely, now, the time was ripe for the Companies to grapple with the sulphur problem. It needed but the man to point the way! He was forthcoming, in the person of Lewis Thompson, a practical chemist, and the friend of Faraday, Brande, Ure, Evans, and Mann. For fifteen years he had been making testings of coal gas, during the last three or four of which he had been working on the problem of purifying it from bisulphuret of carbon, during which, as he says, he made upwards of "3000 experiments upon 1400 different salts and oxides." In substitution for the well-known Letheby sulphur apparatus, he proposed passing the gas to be tested, first purified from sulphuretted hydrogen, through a porcelain tube containing baryta heated to dull redness—the deposited carbon being burnt off by a current of oxygen. The operation was such a simple one that he proposed to apply it on a practical scale. In conjunction with Evans, this was done at the works of the Chartered Gas Company; and Thompson reported that, "Complete success has resulted. The purification of coal gas from every form of sulphurous contamination is no longer a doubtful problem, but an established fact. . . There is no appreciable loss of illuminating power. . . I have purified considerable quantities of gas in this way. In practising the system, a perpendicular retort would prove most convenient. The arrangements are, however, more exactly within the province of the gas engineer than the chemist. The principle is merely to pass the gas over lime heated to a dull red or much lower; or small pieces of brick or pumice stone previously steeped in a solution of the chloride of platinum." He also considered it was not even requisite to remove the sulphuretted hydrogen. Whether this was done or not in the practical trials, I am unaware.

Thompson died in 1889. A portrait of him is included in the septet of celebrities which forms the frontispiece of the volume of the "Journal of Gas Lighting" for 1851; his companions being Clegg, Malam, Lowe, Kirkham, Alfred King, and Neilson.

### Bowditch and Purification by Heat.

From this time purification by heat seems to have lain dormant, until it was revived by Bowditch in his patent of 1860. In this process he proposed to pass the gas, first purified in the cold in the ordinary manner, through heated clay, oxide of iron, or lime; the temperature found most efficient being between 140° and 215° C. By these means, the sulphur compounds found in the ordinary purified gas were decomposed; the sulphuretted hydrogen produced, together with some ammonia, being afterwards removed in the ordinary way. Bowditch's patent was not published until December, 1860; but in June of that year he delivered a discourse at Wakefield (where he was Incumbent of the church of St. Andrews) to a body of "directors and managers of the gas-works of Great Britain," in which his process was described. I cannot find any published reference to the address or the audience. Probably since he was somewhat contemptuously referred to six years previously in connection with his first purification scheme as a "money-making parson," he was in this instance ignored.

His address was reprinted "by request;" and there are some passages in it which are so important that I must quote them. "Formerly," he says, "gas was thought to be in a satisfactory state if it did not affect lead or turmeric paper; but henceforth neither gas companies, nor public authorities, nor consumers ought to be satisfied with so unsatisfactory a test." Anticipating an objection by directors of gas companies to the increased cost, he asks: "But is perfect purity incompatible with present dividends or even with an increase? I think not. I assume that the improvement will involve an outlay of 1d. per 1000 cubic feet. I assume an excessive sum on purpose. If we take the average annual consumption of gas in dwelling-houses to be 25,000 cubic feet, the cost of the extra purification will be 2s. 1d., or rather less than ½d. per week. If we ascend to a more wealthy class of consumer who burns 50,000 cubic feet per annum, the cost would be 4s. 2d., rather less than 1d. per week. Can it be they would rather have the sulphur than pay 4s. 2d. a year for its removal?" But he goes on to say that with sulphur-free gas it would be used in private dwellings with greater freedom; and the extra consumption would in the long run more than counterbalance the additional cost. Moreover, he points out that, while with clay

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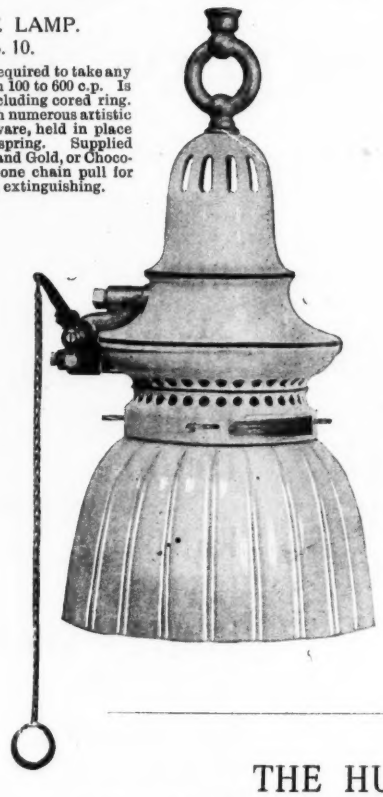

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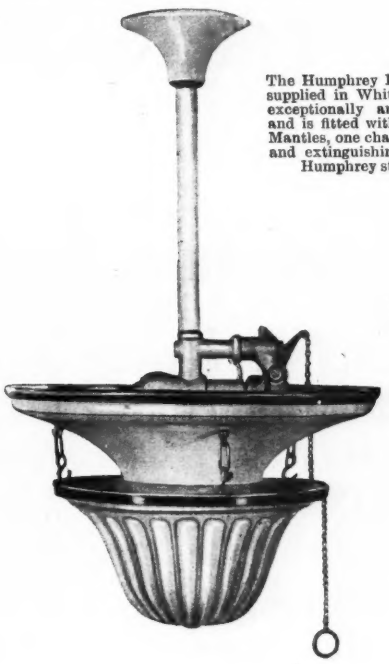

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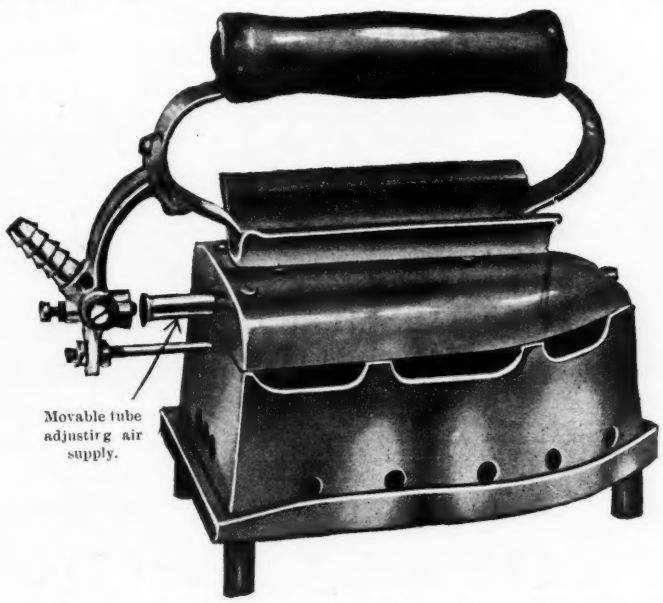


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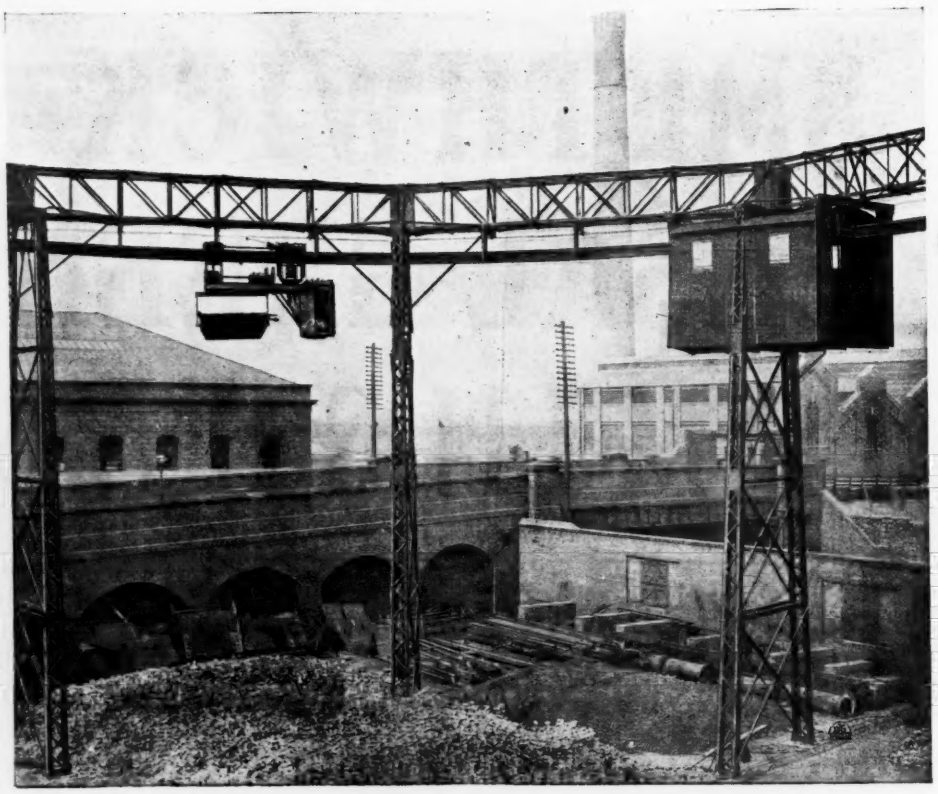

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retorts the yield of gas is higher, so also are the sulphur compounds. "By my process," he adds, "a company may remove the sulphur compounds generated at very high temperatures, and thus select a carbonizing temperature which will give them the largest return in gas." In passing, I may mention that the reappearance of sulphuretted hydrogen in purified gas was first pointed out by Bowditch as due to the reaction between bisulphide of carbon and ammonia, in a paper prepared by him dealing with his purification process, and communicated to the Royal Society in 1860.

Bowditch afterwards became a Fellow of the Chemical Society, for which the knowledge displayed in his book (published in 1867 by Spon) on "Gas Analysis" certainly entitled him. But nothing came of his purification process, which was not regarded with favour by an industry the organ of which looked upon the cry for pure gas as a "morbid one." Perhaps what condemned it most, however, in the eyes of the gas maker was that heating the gas was found to greatly damage the illuminating power.

### Work of Other Investigators.

Thus Kitt, in 1861, found that taking gas of 14-candle power and heating it to 150° C. in contact with broken firebrick, as suggested earlier by Brothers, it was reduced to 8·5 candles; while two subsequent heatings brought it down to 5·75 candles. Conclusions of the same character were arrived at by Barlow and Ellissen, who, in 1863, were engaged to investigate and report upon the troublesome sulphur question in the Metropolis. They reported the following year. Barlow found that, while the Bowditch process did not reduce the sulphur compounds, it brought down the illuminating power of the gas, which Ellissen confirmed. The latter investigator was struck by the fact that the sulphur in Paris gas was only one-fourth that of London, and as the result of a series of very careful experiments believed that the form in which the sulphur existed in the coal was the all-important factor in determining the sulphur content of the gas with similar conditions of carbonizing. Reversion to low heats he considered impracticable, owing to the cramped size of the London works; and he finally came to the conclusion that only in the careful selection and picking of the coal was a remedy to be found.

Dr. Eveleigh, in 1869, proposed, in order to get over the increased sulphur compounds formed at high temperatures, as well as for other reasons, to carbonize the coal at a low heat, and afterwards effect a second distillation of the products in another retort. The process was tried at Barnet, where a make of 11,000 cubic feet per ton was claimed, with a sulphur content of 7 grains per 100 cubic feet. It seemed so promising that plants were put up by the late Sir George Livesey at Old Kent Road, and by H. P. Stephenson at Sydenham. But the results do not appear to have justified expectations. The Company was wound up in 1874, after some financial jugglery (including the talked-of sale of American rights for a quarter-of-a-million sterling), a parallel of which may be found in quite recent times.

Meanwhile, the Great Central Gas Company had not been idle; and the report by Robert Harris, the Engineer, of the progress attained up to this time is interesting. He says for fifteen months every visible piece of pyrites was hand-picked from the coal; but the result did not justify the waste and cost. Slaked lime was then mixed with the coal; but very little good was effected. Afterwards during three months the gas was led through red-hot tubes in conjunction with steam; but the decomposition of the gas produced such a deposit of soot that the process was abandoned. For another three months the gas was passed on a large scale through red-hot pipes charged with various materials But only one-third of the sulphur was removed; and the difficulty of heating the tubes and re-purifying the gas was so great that the process could not be worked.

### Professor Vernon Harcourt's Proposals.

The next serious advocate of purification by heat was Professor Vernon Harcourt, who, in 1870, proposed to decompose the sulphur compounds, other than sulphuretted hydrogen, contained in coal gas by placing a mass of iron turnings or wire into the mouthpiece of each retort; or alternately conducting the gas, before reaching the purifiers, through a system of tubes heated to redness and partially filled with suitable surface-presenting material. It was in the same year that the Beckton works were opened—coming into partial operation in December; and soon afterwards the sulphur question again attained an undesired notoriety, owing to the failure of the plant to deal with it though the purifiers had been doubled in area. A year later Evans suggested the admitting of a jet of superheated steam to the ascension-pipes—a proposal that was regarded favourably by the Metropolitan Gas Referees.

Lecturing before this Institution in 1872, on the sole topic of carbon bisulphide, Dr. Odling referred to Harcourt's proposals and the conviction that they could be practised on a manufacturing scale without any deterioration in illuminating power; and he pointed out that the uniform heating or reheating of a considerable volume of gas had proved difficult in practice. Odling's strong predilection seems to have been for what was afterwards known as the Beckton system, using lime as hydrate and sulphide in separate vessels. On the other hand, we can see from a discourse delivered by Harcourt during the following December that he was not a believer in the difficulties referred to proving insuperable, or, indeed, of the existence of any peculiar difficulty, though he confessed the problem was one for the engineer rather than the chemist.

In 1874 he became associated, at the suggestion of the Board of Trade, with Dr. (afterwards Sir William) Siemens, in an attempt to work the process on a large scale at Horseferry Road. The apparatus consisted of two chambers containing chequer brickwork surmounted by pebbles, and connected by means of tubes which were heated by a furnace. Gas was passed alternately in either direction, with the object of utilizing its waste heat as in the reversible recuperative furnace. The carbon deposited was burnt-off by shutting-down and drawing air through the plant. Harcourt's work and hopes upon the subject were very fully dealt with in the lecture he gave to the members of this Institution the following year. The cast-iron tube-plates of the large-scale apparatus seem to have been badly cracked by the heat, with the result that there was considerable leakage; and so the trial was discontinued. On the same occasion he showed his colour test in its original form, pointing out how its simplicity as an indicator of sulphur compounds gave promise of its application on a large scale.

### Work of Later Investigators.

John Clark, of King's Cross, two or three years later constructed a plant with a capacity of raising 60,000 cubic feet of gas to 315° C. Instead of applying the heat directly to the reaction tubes, he surrounded them with a hot-air chamber, which was in turn heated by a furnace. He states the reduction of sulphur on a working scale to have been only 25 per cent., and that the experiment was abandoned because of the expense, danger, cost, loss of gas, and loss of illuminating power.

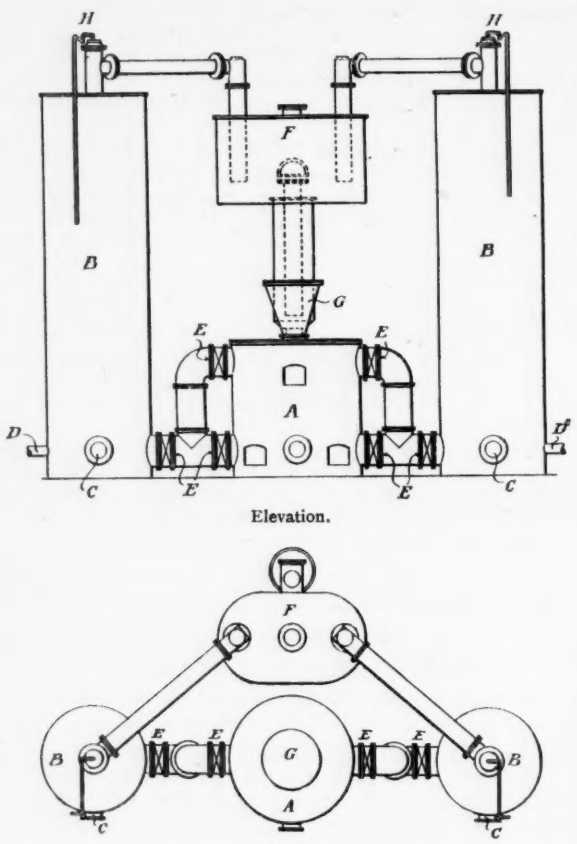
The next hopeful proposal was made by Julius von Quaglio, the Chief Engineer of the gas-works at Stockholm, who, in 1878, proposed the use of heated clay balls impregnated with the chloride of a metallic catalyst or such metals themselves in powder. In conjunction with Versmann, the following year he amplified his proposals by the inclusion of practically all metallic catalysts, and specified the working temperatures as between 216° and 288° C. The apparatus was to be used after the oxide purifiers; the sulphuretted hydrogen produced being subsequently absorbed in additional oxide vessels. Three years later the process was again alluded to as offering great advantages, despite the wear and tear of the cast-iron tubes. It is more than probable that in these lay the cause of ultimate failure.

Greville Williams, the Chemist to the London Gas Company, seems to have been impressed with the possibilities of purification by such a process; for he made a long series of experiments into the value of various catalysts and the best speed required to pass gas over them. Two papers communicated by him to the "Journal of Gas Lighting" in 1883 are well worthy of study by those interested in the scientific aspects of the question. In the same year, the so-called "Cooper Process" of mixing lime with coal before carbonizing was tried for some months at the Vauxhall works of the South Metropolitan Gas Company. It was discontinued for various reasons, among them being disappointment at the absence of a substantial increase of ammonia, which was an important claim of the patentee. A little earlier Lugo and Lees in Germany, and Lewis T. Wright in England, proposed the admixture of 2½ per cent.

of air prior to heating to between 200° and 260° C.; but the idea does not seem to have passed beyond the experimental stage.

### Theoretical Considerations.

In the foregoing, I have endeavoured to sketch, all too briefly and hurriedly, the history of purification by heat from its earliest conception up to present times. But before we turn from the domain of experiment to that of practice to-day, let me devote a few minutes to theoretical considerations. What is the heat process all about? What does it do? I have told you it was Brande who first suspected carbon bisulphide in purified gas; but its presence was first demonstrated by Thompson, though the credit of this has been erroneously attributed to Vogel [Liebig's "Annalen," No. 86, 1853].




Elevation.

Plan.

A. Generator. B. Reheater. C. Gas Inlet. D. Steam Inlet. E. Valves for Generator Gas. F. Seal-Pot. G. Fuel Hopper. H. Valves for Chimney Stack.

**Fig. 1.—Hall and Papst Process.**

Carbon bisulphide has the formula $CS_2$. At a suitable temperature, and in the presence of hydrogen, it is decomposed in accordance with the equation:

$$CS_2 + 2H_2 = 2H_2S + C.$$

Laboratory experiment has shown that, when pure materials are used, the carbon deposited is in theoretical proportion to the carbon bisulphide decomposed. The carbon is removed by its combustion in a current of air passed through the apparatus, which has to be put out of action for the purpose; the temperature being maintained during the whole operation.

Here is a replica of the original test introduced by Harcourt, and which happens to be the first of its kind with which I worked. It consists of a Florence oil flask filled with pebbles, inverted, and so provided with tubes that a current of gas can be passed through the pebbles while it is heated by a ring burner. The bisulphide is decomposed in accordance with the reaction which I have just given, and the quantity of sulphur impurity indicated by a colour test. Later on the apparatus was greatly simplified into the form with which you are all familiar—platinized pumice taking the place of the pebbles.

### Work of Messrs. Hall and Papst.

The credit for successfully applying the Florence flask reaction upon the large scale belongs to America; and it is due to Messrs. Hall and Papst, of the Portland Gas and Coke Company, Oregon. They first tried a 30-inch cast-iron pipe filled with scrap-iron, and heated by a brick oven. Owing to the low duty obtained, the arrangement was replaced by five 4-inch and eight 3-inch tubes. But the heat destroyed these so rapidly that they were abandoned in favour of a plant with internal heating. The final apparatus patented by Hall is extremely simple, consisting of two superheaters filled with chequer work as in a water-gas plant, and a generator from which they are heated internally and alternately by producer gas. It is clearly shown in the illustration fig. 1. The lighting gas passes through the hot superheater No. 1, where the bisulphide is decomposed. Meanwhile superheater No. 2 is being heated up from the generator; and when No. 1 has cooled down by the inflowing gas so that its duty is too low, the operations are reversed—the lighting gas being made to traverse No. 2, previously raised to the required temperature, while No. 1 is again heated up. The plant was put into successful operation at the works of the Portland Gas and Coke Company in August, 1908; and the following figures give particulars of its working during 1909:—

Table I.

| Month. | Sulphur, Grains per 100 Cubic Feet. | | Percentage Reduction. |
|---|---|---|---|
| | Before Treatment. | After Treatment. | |
| January, 1909. . | 58·8 | 16·9 | 71·25 |
| February . . . | 50·0 | 17·3 | 65·40 |
| March . . . . | 49·0 | 15·5 | 68·36 |
| April . . . . | 58·8 | 14·2 | 75·85 |
| May . . . . | 53·9 | 15·3 | 71·61 |
| June . . . . | 68·5 | 18·0 | 73·72 |
| July . . . . | 68·9 | 20·8 | 69·81 |
| August . . . | 66·7 | 18·2 | 72·71 |
| September . . | 57·8 | 14·7 | 74·56 |
| October . . . | 62·3 | 15·5 | 75·12 |
| November . . | 62·1 | 18·8 | 69·72 |
| December . . | 49·2 | 18·1 | 63·21 |
| Average . . . | 58·83 | 16·94 | 71·00 |

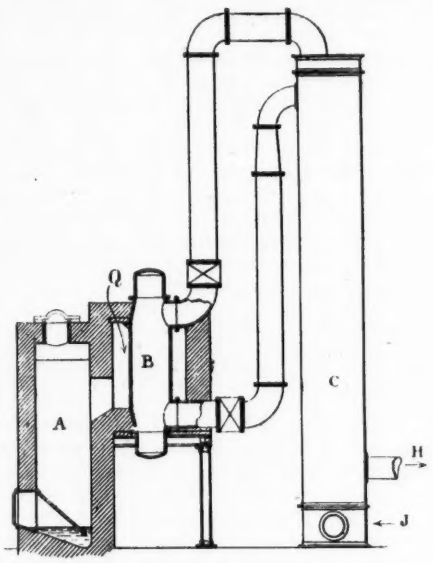
The total gas treated during the year was 817 million cubic feet, with a maximum of 4 millions per diem. The average cost is stated to be ½d. per 1000 cubic feet, including fuel, labour, repairs, and investment.

The only criticisms I have to make regarding the working of the plant arise from the fact that, as the firing is internal, each reheater has to be operated intermittently instead of continuously, which means that its gaseous contents have to be changed before and after each run. I think, too, the high temperature worked (up to 900° C. is suggested) may be a disadvantage, by reducing the illuminating power. In this connection, I should like to draw your attention to Table II., which has been published by the inventor of the process, and in which the importance of high temperatures to effect a good reduction in the sulphur content is clearly shown.

Table II.—*Portland Purification Process: Percentage Reduction of Sulphur Compounds at Increasing Temperatures.*

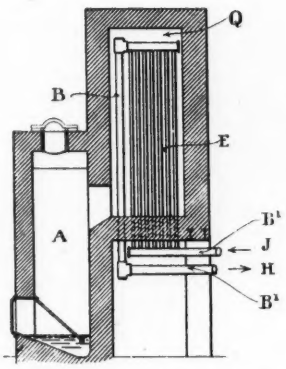
| Temperatures, Deg. C. | Percentage Reduction. | Temperatures, Deg. C. | Percentage Reduction. |
|---|---|---|---|
| 427 . . . . . | 20·7 | 593 . . . . . | 68·8 |
| 454 . . . . . | 36·6 | 621 . . . . . | 71·2 |
| 482 . . . . . | 50·8 | 649 . . . . . | 72·9 |
| 510 . . . . . | 57·8 | 677 . . . . . | 74·5 |
| 538 . . . . . | 62·7 | 704 . . . . . | 76·0 |
| 566 . . . . . | 66·4 | | |

Our own work on the sulphur problem began in 1906. I long had hopes of putting the lime process upon a scientific foundation; and two years were spent in reproducing the classic work of Veley and Divers. One day in 1908, however, Mr. Evans gave me a "facer" in suggesting the Harcourt bulb as a substitute for the tube of alkali. The significance of this appeared in a flash. No carbonic acid troubles! Only those who have had experience with lime purification can know what this means. The effect of 1 or 2 per cent, of carbon dioxide upon the heating, or lighting, or power quality of the gas was negligible; but when lime had to be provided for its absorption, we were confronted with a different problem. From that day we entered upon an investigation into purification by means of catalysts; and it is interesting to note that while we were working in the



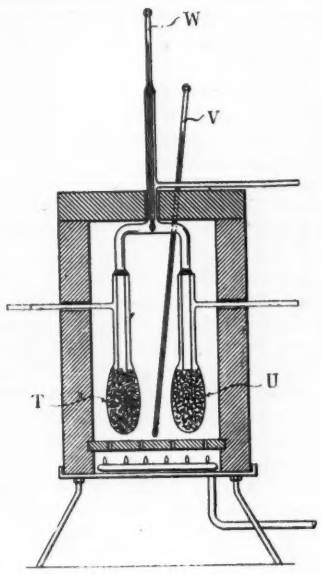

A. Furnace. B. Container for Catalyst. B¹. Collector Tube. E. Gas Preheating System. H. Gas after Treatment. Q. Heating Chamber.

Fig. 2.




C. Heat Interchanger. J. Gas before Treatment.

Fig. 4.




Laboratory Experiment. T. Glass Rods. U. Nickel Catalyst. V. Furnace Thermometer. W. Preheating Thermometer.

Fig. 5.

laboratory the Portland plant was actually being started up, and while we were busy at our Bankside works melting-down purifying retorts or blowing-up furnaces, the Portland plant was working away smoothly, and giving the results shown in the table.

I have more than once spoken of "catalysts." This is, perhaps, a convenient moment to refresh your memories as to what is meant by the expression. A catalyst is a substance which, without apparently taking part in the reaction itself, enables chemical reactions to come about which, in the majority of instances, would only be the case at higher temperatures. An excellent example of this is to be found in the Harcourt test. Compare the first type—the Florence flask full of pebbles heated by a large ring-burner—with the small bulb filled with pumice. The duty required of both is the same—namely, to decompose the bisulphide of carbon with gas passing at the same rate, that required by the colour test, through each. But the pumice has been coated with a catalyst—platinum, in this instance—and that is why it has been possible to so considerably reduce the dimensions of the container and the heating provision.

## Large-Scale Experiments.

I must now deal with our large-scale experiments. Laboratory experiments have taught us that, of all the metals tried, iron was found to have the greatest activity, combined with low first cost. In order to keep down the size and expense of the plant, it was necessary to provide for working at the highest temperature compatible with the maintenance of the quality of the gas, and the durability of the iron container. It was found that a temperature between 400° and 500° C. fulfilled these conditions; and in 1909 the apparatus shown in fig. 2 was erected at Bankside works. Two serious difficulties soon manifested themselves. Although the retort was heated to low redness, the temperature of the gas issuing from it was only raised to 200° C. The next difficulty arose in revivifying the contents of the retort by means of a current of air. The action was so intense that not only was the catalyst fused into a mass, but a large hole was melted out of the retort. We then began again in the laboratory an investigation into various kinds of catalysts and the best manner of applying them.

Now, if you look at fig. 3 you will see just what happens at different temperatures with a constant rate of flow of gas, and when using different catalysts or none at all. Look how low the duty is for fire-brick or untreated pumice. See how high it rises with an active catalyst, such as nickel or platinum. We, fortunately, do not need to use the expensive metal, though I was prepared to back my belief in the need of efficient purification to the extent of purchasing £25,000 worth, if necessary.

It was found that catalysts, deposited on nuclei such as fire-clay or asbestos, required greater contact surface than

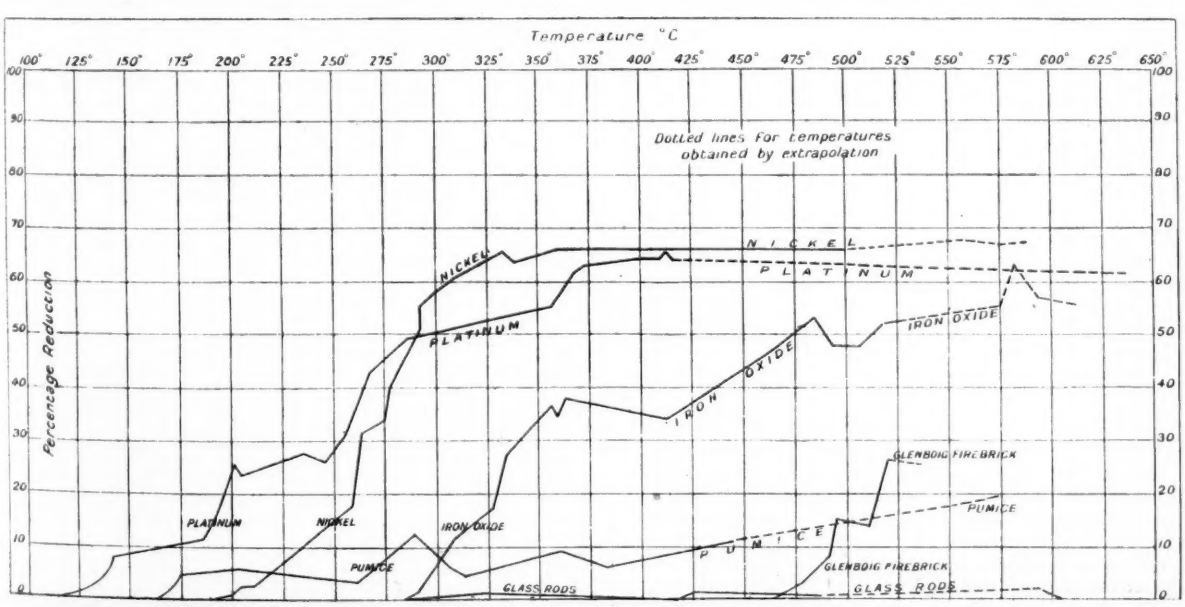

Temperature °C
100° 125° 150° 175° 200° 225° 250° 275° 300° 325° 350° 375° 400° 425° 450° 475° 500° 525° 550° 575° 600° 625° 650°
Dotted lines for temperatures obtained by extrapolation
Percentage Reduction
NICKEL
PLATINUM
IRON OXIDE
GLENBOIG FIRE BRICK
PUMICE
GLASS RODS

FIG. 3.—EFFICIENCY OF CERTAIN CATALYTIC AND CONTACT SUBSTANCES WITH INCREASING TEMPERATURES.

when the metals themselves were employed. Using iron-oxide in this way thus became impracticable, owing to the size of the apparatus which would have been required. Taking all circumstances, it was found that reduced nickel was the most active, and that its cost would not be prohibitive. The apparatus from which the curves on fig. 3 have been plotted is shown in fig. 5. We then substituted for the cast-iron retort shown on fig. 2 four 3-inch tubes, two of which were filled with pumice impregnated with a nickel salt. Again difficulties appeared; for, in order to maintain the catalyst at 450° C., which was the temperature experiment taught us as necessary for 70 per cent. reduction of bisulphide, it was necessary to work the furnace at 650° C., and the reaction tubes were speedily destroyed. We next substituted for these a 2-inch U-shaped tube, one limb of which, being empty, served to preheat the gas before passing on to the second limb, which contained the catalyst. With this, we obtained the required efficiency with a furnace temperature of 425° C. But the 2-inch tubes were considered too small for large-scale work, so a 6-inch pipe was now used to contain the catalyst, with a series of 2-inch ones for preheating—see fig. 4.

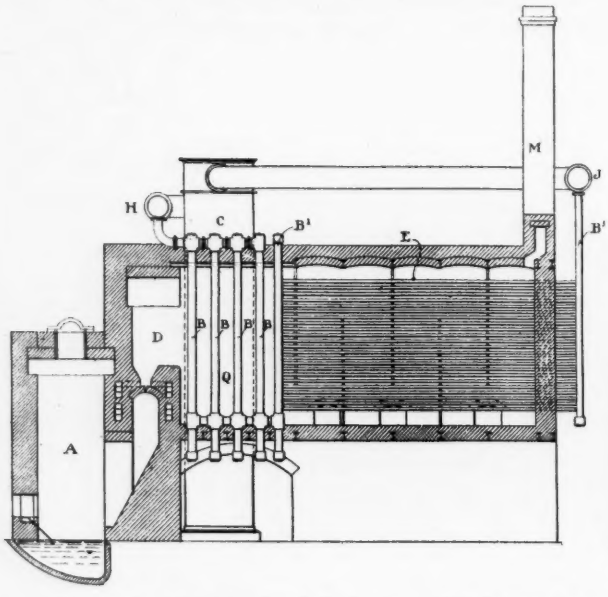
### Advantage of Preheating.

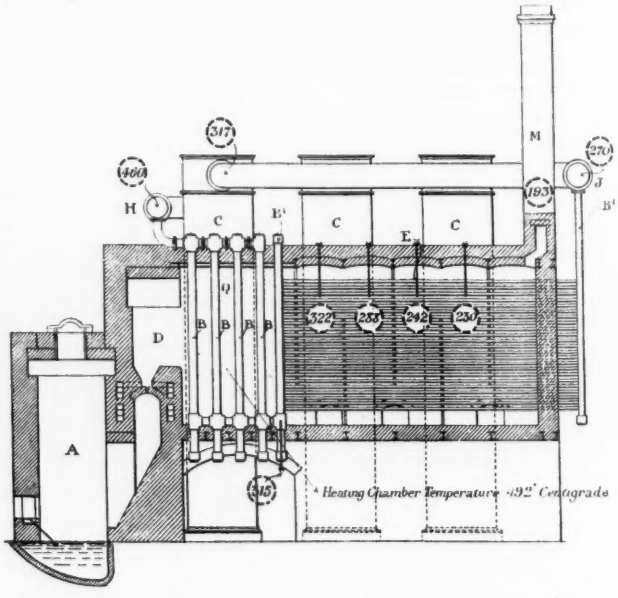
I have been talking of preheating; and I now want to show you an experiment which will demonstrate the advantage of this. A current of gas is passing through the test-meter, and then through a U-tube contained in a water-bath, where it receives a uniform supply of the vapour of carbon bisulphide, by which the sulphur content of the gas is brought up to about 50 grains per 100 cubic feet at a constant rate of flow of 5 cubic feet per hour. I pass ½-foot per hour through a Harcourt apparatus, and thence into a standard iodine solution; and you will see that the colour is discharged in about 60 seconds by the decomposed sulphur compounds. The iodine, you see, is now colourless. In this furnace on the table I have a similar Harcourt bulb, with the same capacity and contents. The same furnace contains two other bulbs in series, which contain ordinary pumice; and these can be interposed before the Harcourt bulb or not as required. In the first place, I cut them out and pass the gas through the platinized pumice, which forms the catalyst, not at the ½-foot an hour rate, but at ten times the rate—namely, 5 cubic feet. You see, after 60 seconds, the iodine solution remains the same colour; the bulb is being worked beyond its capacity for reduction. But I will now interpose the preheating bulbs, so that the increased current of gas does not lower the temperature of the catalyst below its best acting point. You will see that the colour is discharged in about 60 seconds—the same as in our first experiment—but with a tenfold rate of gas flow.

The next plant erected was one of 1⅛ million cubic feet capacity per day; and you will see from fig. 6 how largely the preheating system figures in it. This plant worked so well that it was decided to extend it by the erection of a 10 million cubic feet apparatus, so as to purify the whole of the Old Kent Road works make of gas. This was ordered; and while it was in course of erection further experiments were made with the 1⅛ million unit. The result of these is shown in fig. 7, from which it will be seen that the preheat given by the regenerators is largely lost by radiation. It was too late to make any alteration, however, so the modification had to be reserved for the East Greenwich plant, which is shown in fig. 8.

### The East Greenwich Plant.

Let me now describe the East Greenwich plant—fig. 8. It consists of five units, each capable of dealing with 3 million cubic feet per day. Each unit consists of a producer A and a combustion chamber D, on either side of which are heating chambers Q, which contain the reaction tubes B. The gas, freed from sulphuretted hydrogen, flows through the pipe J into the heat interchangers C C¹, which are wrought-iron vessels filled with 3-inch tubes. The hot gas leaving the heating chambers flows through these heat exchangers in the contrary direction—giving up a large proportion of its heat to the inflowing gas. This gas is further raised in temperature within the heating chamber, and then flows in parallel currents through the reaction tubes, passing from them into the collector pipe B¹, then through the heat interchangers in the reverse direction to the incoming gas, and finally to the secondary purification vessels.




A. Furnace. B. Tubes containing Catalyst. B¹. Collector Tube. C. Heat Interchangers. D. Combustion Chamber. H. Gas after Treatment. J. Gas before Treatment. M. Chimney. Q. Heating Chamber.

Fig. 6. LONGITUDINAL SECTIONS. Fig. 7.

Of each pair of heat interchangers, one is efficiently jacketed, the walls of the other being bare, thereby allowing some loss of heat, so that the temperature of the gas entering the secondary boxes is kept within working limits. The gas is preheated to about 400° C., and the reaction takes place at 430° C. The total weight of metallic nickel in this particular plant is 1321 lbs., which, at £160 per ton, would cost £94. The walls and bases of the heating chambers are made thick, to prevent radiation losses. The top covering is constructed with two layers of light sheet-steel troughing, sealed in sand, and placed 2 ft. 6 in. apart, so as to form an insulating chamber, which would be easily blown off in case of any unanticipated accident happening to the plant.

The whole plant consumes 5½ tons of coke per day, which is fed into the producers A from the coke-hopper N (shown on the left of the diagram) by means of a telpher. On the right hand of the diagram is shown the aërating plant, consisting of a small gas-engine driving a fan, and a meter to indicate the volumes of air or furnace-gas dealt with. P is the laboratory for controlling the operations. With regard to the primary and secondary purification of the sulphuretted

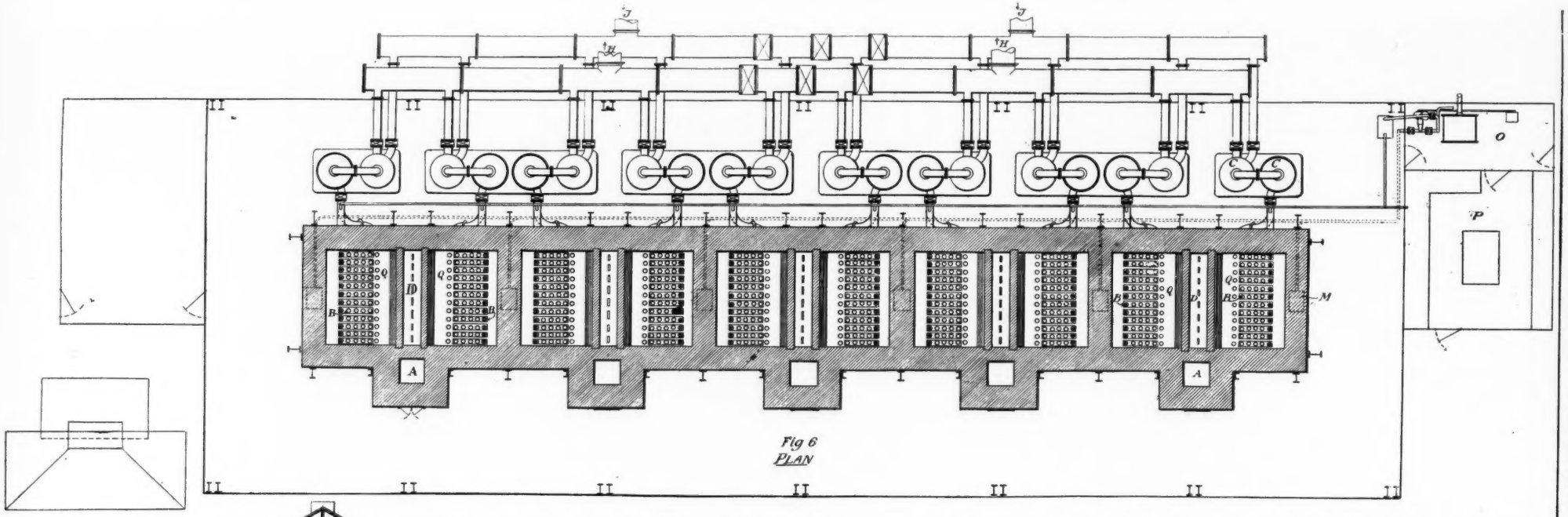
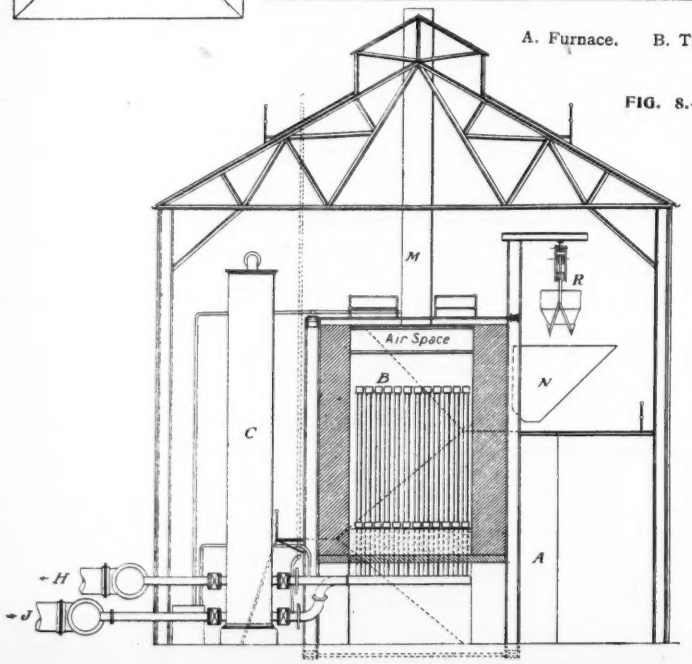



*Fig 6*
*PLAN*

A. Furnace. B. Tubes containing Catalyst. C. Heat Interchangers. D. Combustion Chamber. H. Gas after Treatment. J. Gas before Treatment. M. Chimney. N. Coke Hopper. O. Aëration Plant. P. Test Room. Q. Heating Chamber. R. Coke-Handling Plant.

**FIG. 8.—SULPHUR PURIFICATION PLANT AT THE EAST GREENWICH WORKS OF THE SOUTH METROPOLITAN GAS COMPANY.**




hydrogen, this is carried out in all our works by a series of four purifiers in the first instance and two in the second, simply because this was the arrangement of vessels provided for lime purification. But it is not an essential of the process where four purifiers only are in use. A centre-valve, or group of valves performing the functions of a centre-valve, could be introduced as an addition to the ordinary connections required for working four purifiers in rotation. By these means, the sulphur extraction plant could be interposed between any two boxes of the set.

### Durability and Efficiency.

As regards the durability of the plant, I can only give you partial information. We have had the 1⅛ million plant in operation for two years, during which we have treated with it 400 million cubic feet of gas. I have had one of the 6-inch tubes cut out from it; and it may be inspected by any who are interested. You will see that the internal wasting is very slight; the outside is *nil*. I have also samples before me of the catalytic material. Here are the fire-clay balls; and here is the nickel salt. Here are the impregnated balls ready for use, side by side with those removed from a tube with the carbon deposit untouched. If I wipe one of them with a linen rag, you will see the soiling produced by the deposit. This is burnt off at intervals, leaving the balls in their original condition. As far as we have gone up to the present, the efficiency of them has been unimpaired by use. The burning-off process is interesting. When the particular unit is shut down, the gas contained in it is displaced by chimney gas, and then air in regulated quantities is driven through by the fan. When the combustion of the carbon is complete, as indicated by the baryta test, the residual air is in turn swept out by chimney-gas, and the plant is ready for use.

As regards the efficiency of the apparatus, this is shown

from the starting of the respective plants to the end of last month.

TABLE III.—*Working Results of Sulphur-Extraction Process.*

OLD KENT ROAD PLANT: JAN. 24, 1913, TO MAY 31, 1914.

| Date. | Gas Treated, Cubic Feet. | Sulphur, Grains per 100 Cubic Feet. | | Percentage Reduction. |
|---|---|---|---|---|
| | | Before Treatment. | After Treatment. | |
| Jan. and Feb., 1913 | 217,919,000 | 39·60 | 7·23 | 81·7 |
| March | 217,689,000 | 42·02 | 9·06 | 78·4 |
| April | 187,577,000 | 38·91 | 8·42 | 78·4 |
| May | 113,968,000 | 34·15 | 7·62 | 77·7 |
| June | 99,019,000 | 50·00 | 10·66 | 78·7 |
| July | 109,360,000 | 36·64 | 7·95 | 78·3 |
| August | 116,512,000 | 44·16 | 8·13 | 81·6 |
| September | 106,554,000 | 36·16 | 8·08 | 77·7 |
| October | 119,977,000 | 32·88 | 8·12 | 75·3 |
| November | 127,526,000 | 28·05 | 6·83 | 75·7 |
| December | 215,479,000 | 38·81 | 8·01 | 79·4 |
| January, 1914 | 220,728,000 | 37·00 | 8·14 | 78·0 |
| February | 139,988,000 | 45·19 | 8·17 | 81·9 |
| March | 156,366,000 | 38·23 | 7·38 | 80·7 |
| April | 109,827,000 | 45·34 | 7·68 | 83·0 |
| May | 77,287,000 | 48·73 | 10·04 | 79·4 |
| Totals and averages | 2,335,776,000 | 39·74 | 8·22 | 79·3 |

EAST GREENWICH PLANT: APRIL 2 TO MAY 31, 1914.

| | | | | |
|---|---|---|---|---|
| April, 1914 | 163,255,000 | 31·57 | 6·99 | 77·9 |
| May | 320,633,000 | 38·57 | 8 66 | 77·5 |
| Totals and averages | 483,888,000 | 35·07 | 7·82 | 77 7 |

The maxima and minima efficiencies are also interesting; the highest percentage being, as might be expected, with the high-content sulphur.

TABLE IV.—*Effect Produced on Gas of High and Low Sulphur Content.*

| — | Sulphur, Grains per 100 Cubic Feet. | | Percentage Reduction. |
|---|---|---|---|
| | Before Treatment. | After Treatment. | |
| Maxima | 63·78 | 10·34 | 83·8 |
| Minima | 19·21 | 5·34 | 72·2 |

The quality of the gas before and after catalytic treatment is shown in the following table:

TABLE V.

| — | Before Treatment. | After Treatment. |
|---|---|---|
| Illuminating power . . . . . candles | 14·70 | 14·7 |
| Calorific power . . . . gross B.Th.U. | 590 | 594·4 |
| Naphthalene . . . grains per 100 cub. ft. | 5·54 | 4·71 |
| Hydrocyanic acid . ,, ,, ,, ,, ,, | 22·19 | 18·75 |
| Analysis— | | |
| $CO_2$ per cent. by volume . . . . | 1·44 | 1·45 |
| $C_nH_m$ . . . . . | 3·55 | 3·63 |
| $O_2$ . . . . . | 0·33 | 0·06 |
| CO . . . . . | 8·16 | 8·03 |
| $CH_4$ . . . . . | 26·85 | 27·26 |
| $H_2$ . . . . . | 54·19 | 54·25 |
| $N_2$ (by difference) . . . . . | 5·48 | 5·32 |

In order to extend our knowledge of the effect on the illuminating power of richer gases than are now made, one of the retort-houses, producing 2 million cubic feet per diem, was worked at a temperature so much lower than ordinarily as to produce 20-candle gas. In these circumstances, the average quality leaving the plant was found to be 20·46 candles, while the inlet was 20·54 candles.

The cost of working the large plants is shown in Table VI. The capital cost, including concrete foundations suitable for ordinary conditions, works out at £1500 per million cubic feet of gas per diem.

TABLE VI.—*Cost of Working the Sulphur Extraction Process.*

| | Pence per 1000 Cubic Feet. |
|---|---|
| Fuel (coke at 15s. per ton) . . . . . | 0·099 |
| Conveying coke, clinkering furnaces, and aërating catalytic material . . . . . | 0·058 |
| Power . . . . . | 0·003 |
| Supervision and testing . . . . . | 0·011 |
| Repair and maintenance . . . . . | 0·030 |
| Depreciation and interest (10 per cent. on capital cost) . . | 0·098 |
| Total . . . . . | 0·299 |

EXPERIMENTS WITH AN IRON AND A FIRE-CLAY RETORT.

I referred earlier in my lecture to experiments we carried out with an iron retort. This was a single-ended one 7 ft. 3 in. long, 1 ft. 8 in. wide, and 1 ft. 1 in. deep, built in a direct-fired setting. Taking a standard Durham coal we found that with the production of 7913 cubic feet per ton, it gave an illuminating power of 20·4 candles on the No. 2 "Metropolitan" argand burner, and the sulphur compounds, with oxide purification only, were 19·56 grains per 100 cubic feet; the weight of charge used being rather over 7 cwt. of coal per 24 hours. When the temperature was increased to give a make of 10,942 cubic feet per ton, the illuminating power fell to 18·21 candles, and the sulphur compounds in the oxide purified gas rose to 29·96 grains per 100 cubic feet. A further experiment with the same kind of coal in a fire-clay retort with higher heats yielded a make of 13,219 cubic feet per ton, the illuminating power fell to 15·65 candles, and the sulphur compounds rose to 53·28 grains. In order to ascertain whether the mass of metal in the iron retort was a factor in the lower sulphur content, the retort was coated internally with half-an-inch of Purimachos, but without appreciably altering the results I have given. From this it will be seen that in the days of iron retorts the quantity of sulphur compounds produced must have been comparatively low; and one is inclined to imagine that in striving after the greater yields, which the higher working heats of clay retorts rendered possible, engineers lost sight of a no less important factor in the problem—the quality of the gas produced.

THE LIME TREATMENT OF COAL.

I have already referred to the coal-liming process; and I must not omit to mention the ingenious contrivance by which every piece or lump of the coal to be carbonized is dusted over with lime. But while giving to Mr. Paterson every credit for the ingenuity of the improvement, his published figures only confirm my own experience of the process—that in my opinion it does not take us far enough. In the excellent paper read before the Southern District Association in 1911, he states that the sulphur compounds in the purified gas averaged 20·48 grains per 100 cubic feet. Now it would be possible to achieve such a result as this in another way. Through the kindness of my friend Mr. Drury, we have been able to make some experiments in Sunderland, comparing the sulphur content of gas produced from Dessau vertical retorts. The average of our tests showed 22·31 grains per 100 cubic feet, which is about one-half of what would have been found had the same coal been carbonized in horizontal settings. The average sulphur content of the gas leaving the experimental reduction plant we installed was 5·93 grains per 100 cubic feet—a reduction of 73·4 per cent., which would in all probability be exceeded on the large scale—say, to 4 or 5 grains.

M. GUILLET'S SUGGESTIONS.

I have left to the last a reference to what is in many respects the most interesting of all the processes which have been proposed for purification by heat. I refer to the suggestions made by M. Oscar Guillet, in the paper read by him last year before the Société Technique de l'Industrie du Gaz en France. Guillet's process is based upon the well-known reaction that, in the presence of water, bisulphide of carbon yields sulphuretted hydrogen and carbon dioxide according to the equation—

$$CS_2 + 2H_2O = CO_2 + 2H_2S.$$

This reaction, hardly perceptible when iron is not present and at the ordinary temperature, assumes greater importance and technical rapidity when the temperature is raised. For the reaction to be complete, it is necessary that the sulphuretted hydrogen should be continually absorbed; and an admirable material for this purpose exists in oxide of iron. Gas to be purified is already saturated with water vapour; and therefore all that is necessary after having raised it to a suitable temperature is to conduct it through a purifier containing oxide of iron, itself heated. Tests in the laboratory made by M. Guillet show that, with a sulphur content in unpurified gas of 16 grains per 100 cubic feet, this was reduced by treatment to 4·3 grains. The temperature of the

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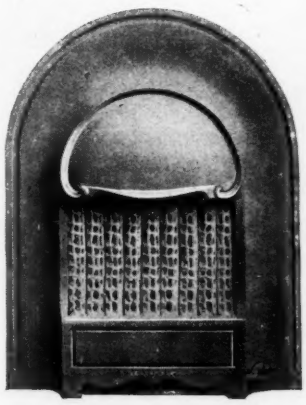

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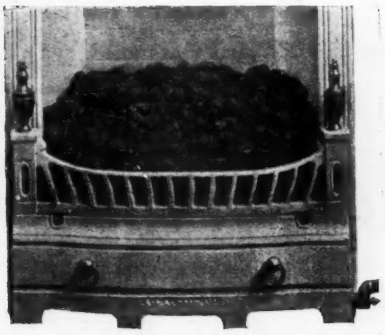

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reaction is as low as 130° C. The process is a very promising one; and I am sure we shall all look forward with great interest to the recent results obtained by M. Guillet, which he will be describing this week in a paper that he is contributing to the French Society. I might point out that the low sulphur in the crude gas experimented with is a characteristic of French coal. But we have every reason to believe, from the experiments we have made, that the reaction holds good with conditions such as we are more accustomed to at home.

### The Lessons to be Drawn.

I have dealt at great length—and I fear in doing so I must have wearied you—with a century's progress in sulphur purification by heat, from the time when it was first suggested by Winsor's assistant Heard, to the present-day developments on the large scale here and in America, and finally the interesting proposals of M. Guillet.

What are the lessons to be drawn from the century's teachings? I have left these, the most important part of my lecture, to the last. I can well imagine hearing it said: "We do not want the lessons; and as you have given us such a dose of 'brimstone,' let us now have the 'treacle.'" But you have already had all my treacle. I have none left—only brimstone; and, disagreeable or not, I must administer the remainder of the dose.

Over and over again chemists have told our industry, not only that lighting gas must be freed from its bisulphide impurity, but how it was to be done. If one-tenth—nay, only one-hundredth—part of the time devoted to perfecting retort-settings had been given to making purification by heat practicable, would our industry stand where it does to-day? Is it not probable we should have been spared the lamentations of the gas-works manager who was recently bewailing in the Press his lost lighting load? Engineers have all too long concentrated their attention on dividend making in the retort-house, to the neglect of dividend losing by the inadequacy of their purifying-house. Bowditch, the first lecturer upon the subject to a body of gas managers, pleaded for the adoption of his solution of the problem—pointing out at the same time its commercial soundness. Your first President, Thomas Hawksley, raised his voice emphatically in favour of complete purification and the gain to be derived from it. Over and over again Letheby, one of your earliest Honorary Members, pointed out the urgency of the need for pure gas. Earlier still, Thompson, the chemist, had shown the way in which this was to be achieved, and in the accomplishment of which Evans failed, just as Siemens did many years later with the proposals of Harcourt. And what was the final remedy suggested for the trouble? Not to mention it! Almost as sensible as to mix 20 per cent. of nitrogen with coal gas, and call it power gas because it is blue! What is really wanted is cheap units of light or heat or power as the case may be, not cheap volume. But that is another story.

I am strongly of opinion that irritating restrictions as to sulphur impurity are unnecessary. Gas undertakings *must* take it out in their own interests, if for no other reason. The South Metropolitan Company discovered this soon after they gave up lime; but they did not carry out the ostrich-like policy of a greatly respected friend of mine who, to this day, does not test his gas for sulphur, regardless of the fact that to do so would furnish an excellent check upon the quality of his coals. On the same side as your first President, I can claim one of your very recent ones, Mr. Harry Jones. He has expressed his ideal as being to see gas employed for lighting the boudoir of the most refined lady. Speaking of the Harcourt process some years ago, he gave his opinion that it ought not to be put on one side, and expressed doubts on the completeness of the Horseferry Road experiment, feeling sure that if sustained effort were spent upon the proposal, something might be made of it.

Well! we have triumphed over the difficulties; but how have we done so? The answer to the question brings with it the conclusion of this lecture. We succeeded because of the unrestricted and unreserved collaboration of the chemist and the engineer. Neither Mr. Gibb nor I had the time necessary to be bestowed upon working out the many technical details of such a system as I have described. We gave a general eye to them, and that is all. To our Chief Chemist, Mr. Evans, is due the credit for the chemical and physical foundations of the process; and, he, with Mr. Franks, one of our younger Engineers, has been mainly responsible for translating the process to our large-scale plants. These two gentlemen deserve the lion's share of the credit; and I am glad to have this opportunity of acknowledging it.

If our industry is to prosper as it can, and as it must, chemistry must be its handmaiden, not a *divorcée*. More and more each day it needs the chemist at its right hand, guiding it as a friend with his counsels, probing difficulties, and pointing out pitfalls. Neither must respect the other less if the one thinks in grains and the other in tons; for their respective mental visions are in nearly every case totally different in character.

These are the lessons I hope I have persuaded you may be drawn from a century's progress in purification by heat. If they are taken to heart, as I earnestly plead they may be, I have no doubt the end of a second century will find the industry, to which we are all of us so deeply attached, in a stronger and more impregnable position even than we know it to be to-day.

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The President: Ladies and gentlemen, we have listened to a most interesting lecture, which was just what we expected would be given by Mr. Carpenter. It was rendered in a way that is consistent with all the work he has carried out. In the latter part of his lecture Mr. Carpenter has referred to the relief given by the Legislature in respect to sulphur compounds. Though I have, like you, listened with very great respect to what he has said, and agree with most of his sentiments, I am still of opinion that there was ample ground in 1905 for the removal of the sulphur clauses. We are of opinion that 30 to 40 grains per 100 cubic feet would still leave the gas suitable for the lady's boudoir; and, as one who may speak with more confidence with regard to Liverpool, I would say that in mixing carburetted water gas with coal gas we have always been able to keep the sulphur down to 25 grains. But legislation having given relief to the gas industry, it was realized that our best carbonizing processes could not be carried out and still leave the state of the gas satisfactory; and therefore we were not surprised when Mr. Carpenter took up this question, and endeavoured, by some less objectionable means than the use of lime, to reduce the sulpho-carbons to a very small figure. You have all, no doubt, listened to his lecture and followed his descriptions, which have been so ably given. But I have had the very great pleasure and advantage of being conducted through the Old Kent Road works by Mr. Doig Gibb, and have seen the plant there, which is an engineering problem solved successfully by a chemist and engineer. We have no doubt to-day listened to an epoch-making lecture; and we shall all throughout the gas industry be glad to take up this plant, and make use of it to the advantage of the industry in which we are all engaged. The lecture will also add a very important item to the literature of our industry. We thank Mr. Carpenter for the pains he has taken in research, and in bringing this subject before us so completely up to date. I think there has never been one so interesting brought before a very large attendance at the annual gatherings of the Institution of Gas Engineers. I desire to propose a hearty vote of thanks to Mr. Carpenter for his most valuable contribution [applause]; and I will ask Mr. Goulden to second the proposition.

Mr. T. Goulden (London): Mr. President and gentlemen, it gives me great gratification to be allowed to second the vote of thanks to Mr. Carpenter which has been proposed by our worthy President. I have never listened with more pleasure to a lecture than I did to this one. Right throughout, from beginning to end, there was not a moment when our attention was not actually riveted upon every word uttered by the lecturer. I think it is an ample testimony to the continued industry of Mr. Carpenter that his energies in this direction have not become less, but have rather increased from the days in which we were fellow-students together. While generously giving, as he has done, all credit to the engineering and chemical assistants with regard to working out the ultimate problem he has set himself of the purification of gas by heat, he must have done an immense amount of work in ferreting-out all those details with regard to it from the earliest times in the history of our industry, simply from the historical point of view, apart from any of the figures and the practical effects that may be the outcome of the work he has accomplished. I consider that the Institution and the gas industry at large are greatly indebted to him. As an officer of the Gas Light and Coke Company, I was very glad

to hear that the Company had in the old stations done a great deal of work in this direction. It has always been one of our principles to give the public as pure a gas as possible. I believe strongly that it is no less in the interests of the gas undertakings than in those of the consumers that the purest possible gas should be supplied. We are devoting ourselves to this pursuit no less to-day than we have done in past years, and I think that I may say with a very considerable measure of success. I myself have had the pleasure of visiting the Old Kent Road works, and I saw the earlier apparatus in operation. I also saw the larger apparatus in course of erection; and I must add my congratulations to those of all present here to Mr. Carpenter and to the staff of the South Metropolitan Gas Company for having worked out the problem in so successful a way. At the same time, I should like to join with our worthy President in pointing out that the problem of purification is not the same that it was many years ago when flat flames were in use, and when the consumption of gas in a room was much larger than it is now. The present conditions are very different; and I doubt very much whether at this time of day any company, particularly when coals are dear and other matters are not going so well for us, could possibly put before their consumers an extra penny on the price of gas in order to effect a reduction in the sulphur, unless this is exceptionally high. So long as the amount of sulphur is moderate, I look upon the question of purification rather as a refinement wanted by the few, than a necessity demanded by the many. At the same time, I think it is very desirable, if we can see our way to do it at a reasonable cost, to adopt every means we can to reduce the sulphur to the lowest possible limit, though not by legislation. It is no longer a subject for legislation. I think that time has gone. That it has gone was clearly shown by the Chairman of the Commission that sat in 1904—which included Lord Rayleigh and our friend Mr. William King—who then decided that, as against the general unpleasantness of dealing with lime in purifying vessels, the actual quantity of sulphur taken out was less than the evil effected, and that the inconvenience of dealing with the lime outweighed the advantages of removing the sulphur. This point is of more importance now than it was then. Bowditch was a parson, and it was naturally part of his business to preach against brimstone, even at 1d. per 1000 cubic feet. [Laughter.] I have no doubt that many other parsons would be only too glad to preach in gas-works. I do not know that it has particularly to do with the sulphur question, but I may say that the present Dean of Durham once said that if he could only bring his congregation to our works, and when he was preaching about "hell fire" get them to look into our retort-house, it would do far more than any words he could address to them. With regard to the question of the hygiene of sulphur, we must not forget, when we are being led away as it were by the fascination of a lecture given as this has been, that we have already gone into the matter of the hygiene of gas which contains a certain amount of sulphur. Dr. Rideal, Professor Lewes, and other eminent men, have done a great deal of work in this direction; and their reports are open for all of us to read. All along we have asserted with good reason that, given a reasonably small amount of sulphur—I am not going to speak of 50 or 60 grains per 100 cubic feet, but an amount not exceeding 40 grains—there is very little prejudice to the hygienic use of gas in dwelling-rooms, or even in the most delicate lady's boudoir. What I have said will not, I hope, be received by Mr. Carpenter as a criticism upon his lecture, because it was absolutely beyond criticism. I have the utmost admiration, not only for its substance, but for the manner in which he delivered it; and I think he has made good his claim to be a worthy successor of that very distinguished list of former lecturers to whom he referred. I feel that we can heartily congratulate him, and should accord him a vote of thanks, as I know you will do. [Applause.]

The resolution was unanimously passed.

Mr. CARPENTER: Mr. President and gentlemen, when I listened to my friend Mr. Goulden, whom I have known, as he has told you, from very early days in pupilage in gas, I could not help thinking of a little duty that was turned over to me in the preparatory work which had to be done with regard to the abolition of the penal law relating to sulphur compounds. The Gas Light and Coke Company stood out in the matter, and it was deputed to me to see their then Engineer, Mr. Trewby, and try to persuade him to go with us in getting the abolition. I was successful in doing so, because I used the same argument that Mr. Goulden has advanced. I said: "The elimination of the sulphur compounds is a most important thing when you have in a room three burners using 6 cubic feet of gas per hour; but don't you see that if you have only one, if you have burning (say) 3 cubic feet of gas an hour, you at once automatically bring down your sulpho-carbons in the proportion of 3 : 18." Mr. Trewby at once saw the point, and he joined in the proposals which were afterwards carried through successfully by Sir George Livesey. However, gentlemen, I do urge you to look at this thing from the point of view of those who are immediately concerned with the sale of gas. I think we engineers have in the past—I make confession for myself, at any rate—been too wholly governed by the requirements within the works. I think we require to give a much more open ear in the future than we have done in the past to what those who have to sell our gas have to tell us with regard to what the users have to say about it. And that is the reason why we turned our attention in the way we have done to purification by means of the elimination of sulphur compounds. You remember that the Greek ideal of purity was a flame. My belief is that the day will come when this ideal will be resuscitated, when the ideal illuminant will be a flame burning in each room—a miniature sun, if you will—the products of combustion being only water and carbonic acid. My belief is that we shall one day achieve this as our ideal—a sun burning in each room, and the products of combustion being the same as the human ones—and then I believe gas will take up a stronger position than it occupies to-day. This is the ideal for which we have worked. I have no personal interest in the matter myself. I have given you not only the process which it so happened that we worked out; I have told you of another which I think is even more hopeful; and I have dealt with another which was in earlier use than the one for which we are responsible. But I want to bring it home to you as emphatically as it was brought out in the past, that unless you are going to give up your lighting load—and I cannot conceive that this is in your minds, because my experience is that it is not necessary—I do say take out the whole of the sulphur compounds by all and every means in your power. You do not believe me, I know, any more than you believed those predecessors of mine. But I conscientiously believe it; and it is because I do so, and because I know something not only of the manufacture of gas but of the details of selling it, and of the competition with which we are face to face in our district, that I urge these problems for your consideration. I thank you heartily for the warm way in which you have received my lecture. [Applause.]

## A LETTER FROM THE PRESIDENT.

We have been asked to publish the following letter regarding the discussions on the papers read last week.

The Editor of the "JOURNAL OF GAS LIGHTING."

DEAR SIR,—The Liverpool meeting of the Institution of Gas Engineers is now a thing of the past; but I desire to say a few words about it to-day, so that they may appear in your issue of next week.

I wish to warmly thank all the members who attended the meetings for their kind consideration, from day to day, and their assistance in the heavy task of carrying out the programme in its entirety.

It was with extreme regret that I had to curtail discussion on the various papers; but I would repeat the suggestion that any member who was unable to take part in the discussion of a paper should send a written contribution to Mr. Dunn (our Secretary), who, after bringing it before the notice of the author of the paper, will include it in the report of the proceedings.

The Council had arranged the programme in the expectation that there would be ample time to complete it during the sittings. But, unfortunately, this was not the case; and therefore it was necessary to press forward to an extent that was not fair to the readers of papers, and that limited the discussion in a grievous manner.

I hope that the members will accept my sincere apologies.

(Signed) EDWARD ALLEN.

*Gas Offices, Liverpool,*
*June 20, 1914.*

# PAPERS AND DISCUSSIONS.

## SOME SPECIAL FEATURES IN GAS-WORKS PRACTICE FROM NORWAY.

By B. SCHIELDROP, of Bergen, Norway.

Broadly considered, gas-works practice is the same in Norway as in England and other places. Gas making being an international function, it cannot well be otherwise. Local conditions, however, vary, and will thus influence results. In this respect gas making in Norway offers some special features; and one of these—the writer refers to the local market for coke—will, he thinks, raise a feeling of envy in the bosoms of his English colleagues, when they become acquainted with the prices paid, and the ease with which the important residual coke is disposed of.

The bare statement that, with best Durham gas coals at (say) 12s. a ton f.o.b. Tyne, and freight at (say) 4s. 6d.—making 16s. 6d. c.i.f. Bergen—the corresponding local coke price will be about 28s. a ton for screened, unbroken coke, and about 30s. a ton for broken coke, will be appreciated by any gas man as an excellent economic foundation for gas-making to rest upon.

And these conditions are not temporary. They have their causes in the domestic customs of the people, making coke the common fuel in the majority of town houses. The open fire-place is hardly known in Norway. Stoves for broken coke, with easily adjustable draught, are the standard heating appliances. These stoves require little attention; they will keep the coke aglow for 12 and sometimes for 24 hours; and they give little dust, and absolutely no smoke or soot. This will account, in part, for the clean condition of the atmosphere in Norwegian towns compared with English ones. We have no Smoke Abatement Society, and shall hardly require one.

The open coal-fire is considered a snug and comfortable appurtenance to some English homes. But then ideals in the valuation of comforts of different kinds vary with localities. Norwegian ideals in heating arrangements certainly account for gas-making in Norway having a solid and broad base upon which to rest.

Norwegian gas-works at present supply only about 30 to 40 per cent. of the national demand for coke. The remaining portion is imported, principally from the Tyne district. Hence it will take some time before the market is satisfied by home-made coke alone. During this time the consumption of coke will be considerably augmented.

In Norway coke is sold by measure, not by weight; and here again Norwegian gas-works have an advantage. The coke is generally brought direct from the works to the consumer. Thus extra handling, which breaks off the sharp corners of the lumps, and brings the coke to fill the measure more compactly, is saved. The imported coke, on the other hand, having to pass through rather rough usage—tipping into ships' holds, unloading, &c.—suffers very much. It thus becomes a risky article to sell by measure after having been bought by weight. It will be obvious that engineers of Norwegian gas-works working under such circumstances must do their utmost to keep their coke light and dry; while the encouragement to those in charge of English works to go to great expense and care in quenching coke with a minimum of water does not appear to be so pronounced.

Coke being such a valuable article, it follows that a high make of gas per ton becomes a question of less importance; while the producer fuel account demands very careful consideration. Hence breeze furnaces in Norway become very valuable. In Bergen, the same results are obtained, measure for measure, in heating the horizontal retorts by breeze in step-grates, as in the case of ordinary regenerative settings heated with incandescent coke taken direct from the retorts. The results for the latter are 12 to 13 per cent. of the coal carbonized. The Waddell type of regenerative settings, with eight through retorts, is employed—built by Messrs. R. & J. Dempster, of Manchester. The saving by breeze firing will be obvious when it is stated that a hectolitre of breeze, selling at 4d., gives the same results as a hectolitre of good unbroken coke, selling at 1s.

Diagram No. 1 gives, in condensed form, a graphic representation of economic results of the operation of the gas-works of Bergen from 1857 to 1912-13, and is made up according to the system of the Norwegian Society of Gas Engineers. It shows the cost per 1000 cubic feet of gas made, subdivided under the following heads:—

Beginning at the bottom of each column, the lower part:

A represents salaries, administration expenses, and pensions.

B includes all supplies, labour, maintenance of works, meters, mains, and service pipes, cost of distribution, and sundries (but not cost of street lighting), with receipts from residuals deducted.

$C_1$ represents interest upon loans.

$C_2$ payment to sinking fund.

D extensions paid out of revenue.

Norwegian gas engineers have found this system of presenting economic results of operations a very valuable one, not only in giving them a ready means of comparing the achievements of their own establishments from year to year, but likewise when comparing the results of their own with other gas-works. The location of defects and any striking features are immediately disclosed within one or other of the main groups of costs, which are separable from each other by strongly marked differences in the character of the costs themselves.

The writer ventures to raise the question, Whether a graphic system of this kind, with such modifications as further consideration may suggest, might not be adopted with advantage outside Norway? He will not, however, support this suggestion with any arguments at present. There may be time for such if the suggestion should find response; but he wishes to say that the adoption of some such system could not deprive the "Gas World" analyses and similar statements of any part of their value or utility, nor supplant them in any way.

An inspection of Diagram No. 1 will show an abrupt change in the results obtained at the author's works at Bergen from 1908 to 1909. Capital charges $C_1$ and $C_2$ increased; but running expenses, B, were reduced in greater ratio. In September, 1908, new gas-works were put in operation, and the old ones shut down, which explains at once the change in results. The years following will be seen to present about the same proportion between the groups of costs, with the exception of the last column, which deals with a period of one-and-a-half years. The column for 1912-13 has a rather singular appearance: B (running expenses) has been entirely wiped out, and A (administration expenses) bids fair to disappear as well. During this period, the production was 350 million cubic feet of gas; its net cost, exclusive of capital charges and all extensions, was 0·83d. per 1000 cubic feet. The causes were: (1) Very favourable contracts for coals—9s. 8d. for Easington coal f.o.b.; (2) low freight—3s. 9d. per ton; while (3), on the other hand, a very turbulent coke market raised the selling price of coke to a high figure. After the coal had all been paid for out of the receipts for residuals, about £13,000 was left over; and this amount was sufficient to cover nearly all the other expenses, except the items above mentioned.

Norwegian gas-making has, however, a reverse to its medal. There is keen competition with exceedingly cheap electricity generated from water power. In Bergen a 10-candle lamp can be had for 2s. 3d. a year, a 25-candle one for 4s. 11d., and a 50-candle one for 8s. 3d., irrespective of the number of hours they may be lighted.

Eight years ago, the Bergen Gas-Works sold 30 per cent. of its make for lighting purposes (exclusive of street lighting); at present, the sale is probably less than 5 per cent. The proportion cannot be given with any certainty, because there are no separate meters for lighting purposes. All gas is sold at one price (*i.e.*, 2s. 6d. per 1000 feet) independent of its use. Gas for motors is disappearing in the same direction, although not quite as quickly. But, strange to say, the gas industry has not suffered by this reduction in the supply of gas for lighting. Gas for cooking and heating

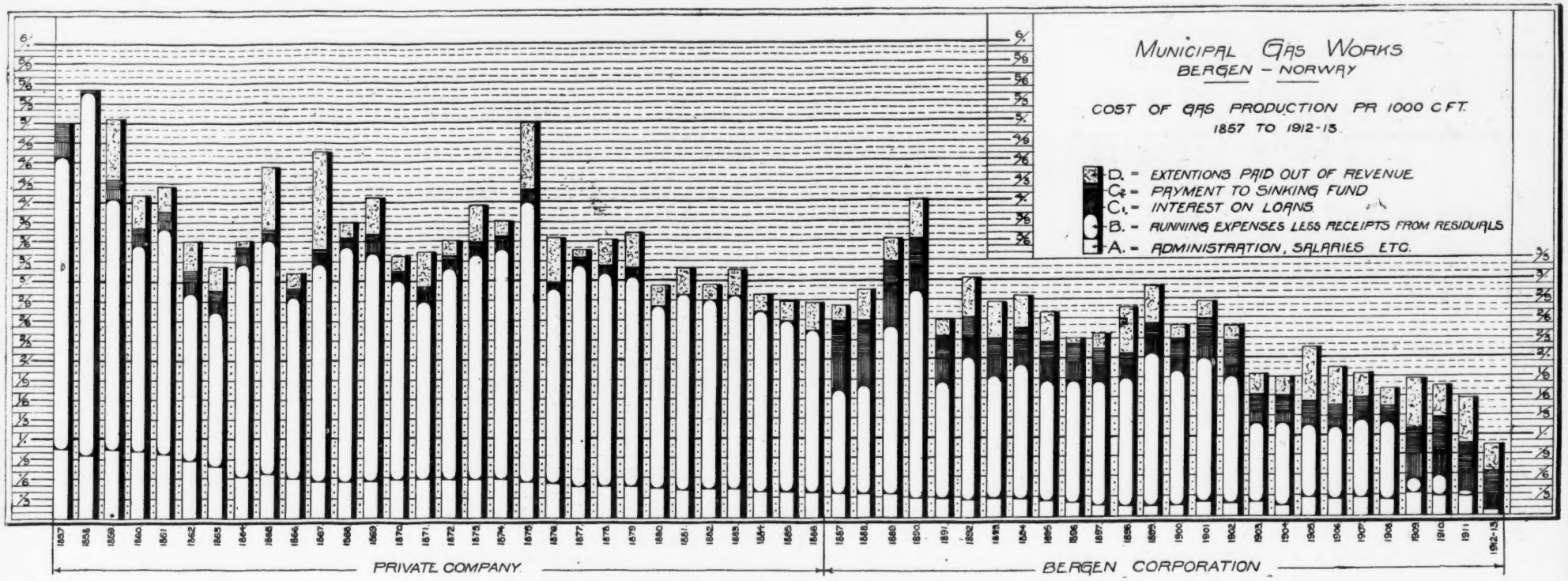
MUNICIPAL GAS WORKS
BERGEN - NORWAY
COST OF GAS PRODUCTION PR 1000 C.F.T.
1857 TO 1912-13.
D. = EXTENTIONS PAID OUT OF REVENUE.
C₂ = PAYMENT TO SINKING FUND
C₁ = INTEREST ON LOANS
B. = RUNNING EXPENSES LESS RECEIPTS FROM RESIDUALS
A. = ADMINISTRATION, SALARIES ETC.
PRIVATE COMPANY
BERGEN CORPORATION

DIAGRAM 1.

has more than compensated for the loss. The increase in sales has never been so great as since the competition with electricity set in.

The increase in gas made last year over the preceding year for the whole of Norway was 15 per cent. For Bergen alone the progress is demonstrated in Diagram No. 2. For the last three years the annual increase in gas sold through meters was between 25 and 33 per cent.; and this in spite of the fact that the population within the district of supply during this period was practically stationary.

When the new gas-works at Bergen were put in operation, late in 1908, everybody said they were built on too large a scale. But three years later three new settings of vertical retorts, on Glover-West's system, were installed; and this year (1914) four more settings of verticals will have to be ordered, and must be in operation during the autumn of next year.

New gas-works will be erected in Kristiania and Trondhjem during the near future, and Stavanger will probably follow soon. Of the smaller towns, six have had gas-works installed in course of the last ten years, others have been rebuilt, and several new ones are projected.

Before building the new works in Bergen, the writer, with his Assistant-Engineer, Mr. Helgeby, visited England, Holland, and Germany to obtain advice and learn how to make good gas cheaply. They received everywhere great kindness and hospitality, and valuable information was candidly and willingly given by foreign colleagues. If the results in Bergen have come out satisfactorily, it is due in a great measure to the valuable assistance so generously rendered. Should good fortune place him in the position of demonstrating his gratitude—for instance by rendering some service to his English friends in aiding ever so little towards making coke a desirable fuel in the estimation of English consumers—he would be glad to feel that he was making a small repayment on a large indebtedness.

## DISCUSSION.

The PRESIDENT: I will now ask you, gentlemen, to discuss the interesting paper that has been placed before us by Mr. Schieldrop.

Mr. J. FERGUSON BELL (Derby): Mr. President and

gentlemen, I am sure the members present would first like me to express to Mr. Schieldrop our great pleasure at seeing him here, and our satisfaction that he should have taken the trouble to come from Bergen to place before us his interesting remarks with reference to gas making in Norway. Those who have had the pleasure of listening to the very admirable synopsis given by Mr. Schieldrop, must have been greatly interested; and certainly he showed us how, when we are short of time, he could give the whole pith of his paper in a few minutes. What I think was especially interesting was when Mr. Schieldrop told us that a few years ago at Bergen they used to have to bury their coke, but that now, owing to the popularization of this valuable smokeless fuel, they are able to sell the whole of their make—and, in fact, they have to import 30 to 40 per cent. to keep their customers supplied. The Lord Mayor, on Tuesday, pointed out in a very able manner what this great city of Liverpool was suffering from—namely, the smoke plague, due, as he said, not alone to the manufactories, but also to the use of bituminous fuel in the domestic grate. I would point out that, in using coal in the way that people are now doing, they

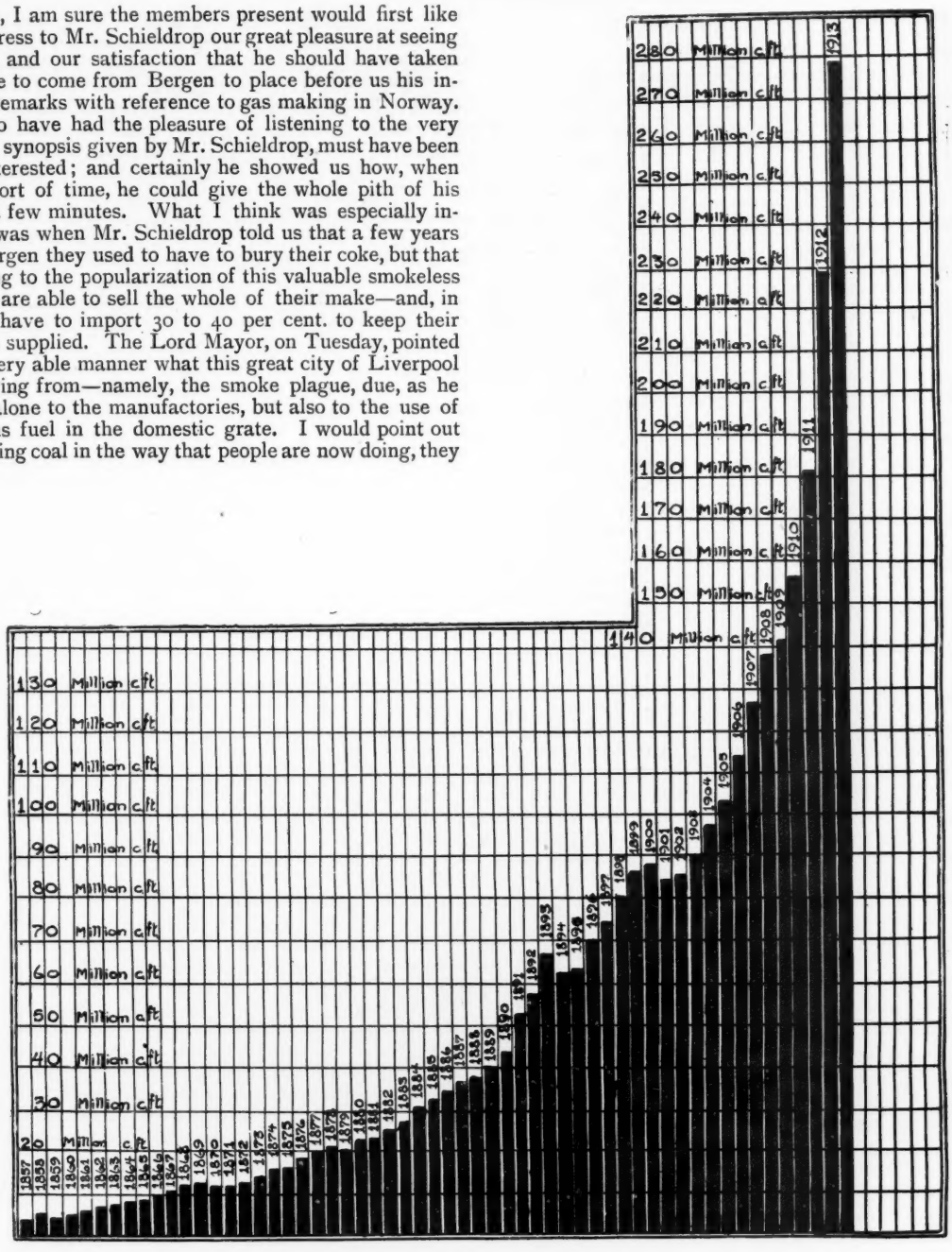


DIAGRAM 2.—RESULTS AT BERGEN.

are not only polluting the atmosphere, but they are wasting an enormous amount of fuel, because I believe that only 10 to 12 per cent. is utilized in heating the rooms, and that the other part is worse than wasted, because it goes up the chimneys, and causes a pall of smoke, discolouring the atmosphere, and so preventing the sun having the beneficial effect which it would have if smokeless fuel were used. Those of us who have been on the Continent will have seen how much better they manage things than we do in England. I hope the time is not very far distant when some of our public authorities will have an ordinance that nothing but smokeless fuel shall be used within the city boundaries. I believe if this were done, it would afford such an object-lesson to all the towns in England that they would not go back upon it, and we should soon have a brighter and a purer atmosphere. While looking through the paper at the hotel this morning, I could not help noticing that the windows were covered with particles of smuts—due, no doubt, to the enormous amount of coal smoke in the atmosphere. We, in England, spend a great amount of money on sanitation; but I venture to think we are leaving one of the most important things unaltered, and that is the pollution of the atmosphere. I was exceedingly pleased that the Lord Mayor should have taken the opportunity of emphasizing the importance of purifying the atmosphere; and I think, if Mr. Schieldrop has done nothing else for us, he has shown us the great advantage of using smokeless fuel. He has told us that in Bergen the price of coke is double that of coal; that he sells more than he makes, and has to import a large quantity. Another thing that struck me as being remarkable was the increase in the price of gas in Bergen, although a great amount of electric light is used there. In conclusion, I would thank Mr. Schieldrop for coming over here to place before us such a valuable paper.

Mr. JOHN WEST (Southport): I have read my friend's paper with great interest. I know him so well, and the work that he is doing in his own country, that I felt sure his paper would be highly appreciated by you all. Many lessons could be learned by us from the way in which they deal with coke in Norway. He craves for coke for sale. He does not care about a big yield of gas; but coke is what he is working for in his carbonizing process, because it pays him better to get coke than large volumes of gas. I am very

pleased indeed to find that his paper has been received so well by you.

Mr. JOHN CARTER (Lincoln): I am sure we are all under a great obligation to our friend for coming over here to read this paper. It is couched in the moderate language for which he is so well known. When he suggests that the reading of his paper might give rise to some feelings of envy among his English brethren, he is very moderate indeed, because what he has said about the coke residual is quite enough to make every one of us green with envy. If we could reproduce in our own works, even to a moderate extent, the conditions appertaining in Bergen this year, most of us would look forward to the financial results of our concerns with less anxiety than we are able to do. With regard to the abatement of the smoke nuisance, we do not seem to be able to get any further forward. Everybody admits the evil; but what is now wanted is somebody strong enough to apply the remedy. I am not sure that the best service Mr. Schieldrop could render us here would not be if he could do something to win the ordinary Englishman away from his love for the open fire. This will always remain a very serious obstacle in the way of the adoption of a smokeless fuel. Diagram No. 1 has been adopted by general agreement among the Norwegian engineers; and when they see a graphic statement like this, they all know exactly what they are comparing their own figures with, and can arrive at a safe and sound conclusion as to how one Norwegian engineer stands in regard to his results as compared with foreigners. I have often wondered whether it would be possible in this country to arrive at something like an arrangement such as obtains in Norway. I want to take the opportunity here of saying that our industry has been for a good many years now placed under great obligations to the proprietors of the "Gas World" for the time, labour, and expense that they have incurred in presenting us every year with a very elaborate and minute account of our important gas undertakings. I do not know that their services in this direction have ever been publicly recognized before; but Mr. Schieldrop's reference to the matter gives me an opportunity of doing so now.

Mr. GEORGE HELPS (Nuneaton): It is somewhat invidious for me to criticize this paper, because not only do I know Mr. Schieldrop as an eminent gas engineer, but I also have him for a close and intimate friend. The way the paper has been prepared, and the manner in which the diagrams have been drawn up, are beyond all praise. Mr. Schieldrop is making cheap gas; and he has told us very plainly why he makes this cheap gas, and that it is entirely on account of the price at which he sells his coke. He has not told us the cost to the public of his competitor, electricity; nor has he said how we could prevent losing the lighting load which he, unfortunately, under his particular circumstances, has lost. I should like to ask Mr. Schieldrop if he has ever considered the advantage of gasifying the coke, and sending it out in the gaseous state, instead of in a solid state.

Mr. J. C. BELTON (Chester): I should also like to congratulate Mr. Schieldrop on the excellent way in which he has put these facts before us. There is a matter I think the previous speakers have overlooked, and that is the great prosperity of the Bergen Gas Company in face of the serious opposition from cheap electricity. One point in the paper could be very profitably brought to the attention of those electrical engineers in this country who are continually advocating the use of electricity for cooking and heating. If electricity, which can be produced in Norway at such a cheap rate, cannot compete with gas and coke for heating, what hope has it of competing with us in this country?

The PRESIDENT: Gentlemen, gas manufacture is indeed international. This common interest has a binding influence upon the nations. Our colleagues from Norway, Sweden, Germany, France, and other countries, are our brethren. There is neither envy nor jealousy, but a sincere wish for each other's welfare. We give our best to each other; and we are grateful to Mr. Schieldrop for his contribution of this paper. Congratulations on his success are offered by us sincerely; and I am sure we are all the better for having listened to his model paper. I will now call upon Mr. Schieldrop to reply to the discussion.

Mr. SCHIELDROP: Mr. President and gentlemen, I thank you very much for the kind and flattering reception you have given to my efforts to tell you something of the conditions of the gas industry in my own country. In reply to the questions which have been raised, I wish to say that I have come over here merely to tell you of conditions existing with us. I fully realize how difficult it is for anyone coming from outside to attempt to give advice to Englishmen as to how they ought to meet the difficulties they have to contend with. Therefore I have only attempted to lay before you the conditions existing in my own country, and ask you to consider them, and, if it can be of any use to you, to apply them according to your best judgment. I should be trespassing if I tried to go beyond this. I can only make an effort to bring the facts home to you. As has been said by one of the speakers, this question of the use of coke was brought out very pointedly at the opening of this congress by the Lord Mayor, when he spoke of looking out of his window, at rather an elevated height, upon the conditions of the atmosphere of this city. He did not state it in these words; but he said something to the effect of there being a lid laid over the city. I think there is a very earnest wish on the part of gas engineers to lift this lid, for the sake of the health and enjoyment of those who live in cities. Mr. Helps raised the question of gasifying the coke. Certainly, it would be an ideal thing to bring the coke in the shape of gas, and supply it through pipes to those who want fuel, instead of bringing it in sacks and carrying it up back-stairs, and then having to bring the ashes out again. It would, no doubt, do an immense amount of good; but I am sure you, gentlemen, will forgive me for not entering at the present moment into this very broad and important question. Mr. Belton asked as to the conditions of the competition between gas and electricity, as fuel, in Norway. This is a question that has occupied our attention to a very considerable extent. Reading the English gas papers, and papers generally, it seems to us that the same sentiments are reflected in both countries, if allowances are made for differences in degree, and for the various ways of saying the same thing. Electrical energy is very cheap with us; and the producers of it are very eager to sell it. They are quite as eager as is the case in England, I should think. We have to meet this competition. But it is very uphill work there, as here, for the electric people to compete with gas; for the simple reason that there, as here, the amount of heat in a unit of electricity falls so very short of the quantity of heat in a unit of gas, having regard to the price to be paid in either instance. In our case, we get cheaper electricity, it is true, because it is produced by water power. Most people, when talking about this matter in a general way, will say: "There we have a waterfall. It is simply a question of putting a turbine into it, laying a wire to the nearest populated place, and then setting up some apparatus so as to get the energy out again." And they will add: "Thus you have heat and light practically for nothing." But this is not the way it will turn out, as you, gentlemen, know. To get the energy transmitted is an exceedingly expensive thing in itself; and then the owner of a waterfall very soon figures out what the real value of the waterfall is to those who want to use it, and he would be a very silly man if he gave the power away for any smaller sum than it would be businesslike on his part to accept. Therefore, when every consideration is taken into account, it is found that electricity cannot be sold for nothing. On the contrary, when electricity has to compete with gas as a fuel, it is driven to the wall. This does not, however, prevent one project after another coming forward. We have seen them being promulgated in such a way that they claim to be able to get several hundreds per cent. of activity out of it—that it can be done very economically, and that it can be produced on a very paying basis. Of course, as soon as these promises are tested they fall to pieces; and then we are enabled to laugh at them. Now, Mr. President and gentlemen, allow me to repeat to you my best thanks for the kind reception you have given to my paper. The principal point I wished to draw your attention to, and wished you to consider, is the manner in which the economic results of gas undertakings could be presented in a very terse and clear manner, so as to enable you, with the least possible loss of time, and without much consideration, to make the necessary comparisons. I think it would save a good deal of discussion if such a way were found; and I speak with some experience when I say that, in our case, it has given us a great deal of assistance.

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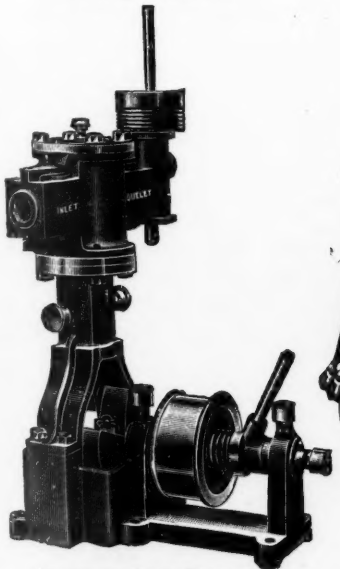


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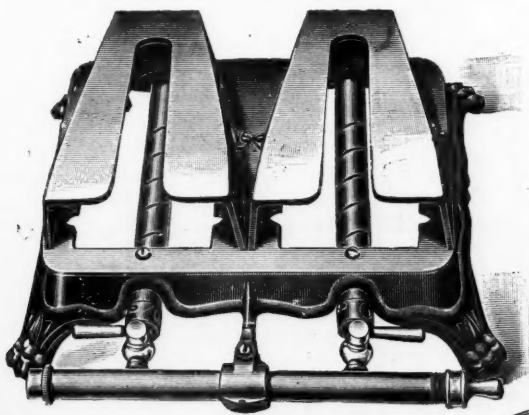

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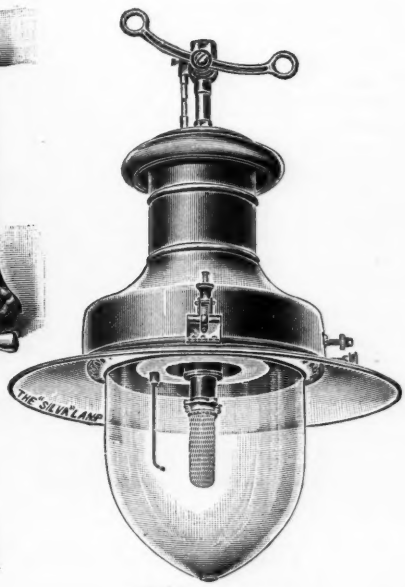


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| Mariendorf (2) | 84 | Halle | 60 | Pirna | 10 |
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| Danziger Strasse | 240 | Harburg | 69 | Providence (2) | 60 |
| Schmargendorf | 80 | Heidelberg | 72 | Providence (3) | 90 |
| Schmargendorf (2) | 120 | Helsingfors | 80 | Reutlingen | 38 |
| Weissensee | 58 | Helsingfors (2) | 60 | Riga | 40 |
| Weissensee (2) | 84 | Hildesheim | 60 | Rio de Janeiro | 140 |
| Holzmarkstr. | 48 | Hochst | 51 | Rio de Janeiro (2) | 140 |
| Holzmarkstr. (2) | 72 | Insterburg | 20 | Rio de Janeiro (3) | 216 |
| Berne | 80 | Insterburg (2) | 10 | Romilly sur Seine | 16 |
| Beziers | 80 | Jena: | | Schneidemuhl | 34 |
| Beziers (2) | 20 | Stadt | 24 | Schonebeck | 32 |
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| Burg-bei-Magdeburg | 26 | Magdedurg (2) | 50 | Turin | 60 |
| Cassel | 90 | Magdeburg (3) | 50 | Vevey | 75 |
| Charlottenburg | 70 | Mannheim | 144 | Warsaw | 144 |
| Chemnitz | 60 | Mannheim (2) | 180 | Warsaw (2) | 180 |
| Chemnitz (2) | 60 | Marseilles | 60 | Warsaw (3) | 180 |
| Chemnitz (3) | 180 | Marseilles (2) | 60 | Wellington, N.Z. | 60 |
| Cleve | 27 | Mayence | 108 | Wellington, N.Z. (2) | 108 |
| Cologne | 240 | Meisen | 20 | Worms | 30 |
| Coblenz | 54 | Merseburg | 30 | Zurich | 100 |
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# CALORIFIC POWER AS A STANDARD.

By JACQUES ABADY.

The subject of calorific power may be looked at from many sides. The object of this communication is not to deal with its technical side, nor with its bearing upon the manufacturing aspect of a gas-works undertaking. As indicated by the title, it is merely to place before the members of the Institution of Gas Engineers some at least of the questions which arise when one considers the utility of calorific power as a standard for parliamentary bargains.

The consideration of this aspect will afford no scope for original thought or expression, but will, no doubt, serve to place on record the past history of the standard calorific power question, and also to initiate a discussion as to the future attitude of the industry in the matter. In fact, a suitable sub-title for this communication would have been "Quo Vadis?"

In looking at the history, one outstanding fact is the comparatively rapid development which has led to what is believed to be a definite position—*i.e.*, that probably Parliament will no longer base the charter of a gas undertaking upon illuminating power but upon calorific power.

It must be borne in mind that, although an agitation has been carried on in the gas world for some years, it is only ten years ago—*i.e.*, 1904—since the Departmental Committee on Gas Testing, presided over by Lord Rayleigh (and of which the then Engineer of the Liverpool Gas Company, Mr. Wm. King, was a member), received evidence and reported. A reference is made here to this report, because, in view of the recent decisions in the Bills of the Gas Light and Coke Company and the Liverpool Gas Company, it becomes of some importance, particularly in its influence upon the decision in these Bills with respect to illuminating power tests.

Now, although the Departmental Committee, while recommending calorific power tests, reported in favour of the continuance of the No. 1 argand burner as a standard burner, the first effect of the report was really to lead to the introduction of the No. 2 "Metropolitan" argand, because the London Companies (following the report) during the parliamentary fights of 1905, which culminated in the London Gas Act, 1905, obtained the right to use a burner which "shall be most suitable for obtaining and in making the test shall be so used as to obtain from the gas, when consumed at the rate of five cubic feet an hour, the greatest amount of light."

The second effect of the report was to lead to the introduction of the flat-flame burner test for information only. Finally, the Departmental Committee's recommendations may be said to have led to the abolition of the sulphur clauses and to the introduction of calorific tests.

Dealing for a moment with the question of illuminating power, the Departmental Committee apparently had considerable hesitation in recommending the continuance of any form of argand burner test, on the grounds that the evidence showed that the argand burner value did not represent the consumer's value, and that the luminous value (if any were required) would be shown by a flat-flame burner. It will appear evident from the foregoing, however, that the outcome of the report was to give the illuminating power test some measure of utility by the use of what may be said to be a rational argand burner—*i.e.*, Carpenter's No. 2 "Metropolitan" argand.

Too much emphasis cannot be laid upon the obligation which is due to Mr. Carpenter—not so much from the industry, but from the public which has benefited most—for his work in this direction; for it is quite clear that, though the argand burner test may go altogether, yet it is the Carpenter No. 2 "Metropolitan" argand which, by standardizing illuminating power tests, seems likely to finally lead to their abolition. Be it remembered, when the obligation to Mr. Carpenter is being measured, that to him is due the re-establishment of the doctrine and precedent that, in testing gas, one is entitled to the maximum result obtainable as a measure of the value of such gas.

The Departmental Committee's reasons for the introduction of the flat-flame burner test may be thus summarized:

Firstly, it was established that the bulk of gas (both for lighting and heating) was used for its calorific power, and that a calorific test should therefore be instituted.

Secondly, it was recognized that a certain small amount of gas was used for its luminosity.

Thirdly, the evidence showed that for the latter purpose the burner used to develop the luminosity was almost invariably a flat-flame and not an argand burner.

It was, therefore, felt that a flat-flame photometrical value would have whatever measure of utility there might be in keeping a record of the value of gas to the flat-flame consumer as such.

From this point the history of the development of gas testing is as follows:

The London Gas Act, 1905, applied to the three London Gas Companies—viz., the Gas Light and Coke, South Metropolitan, and Commercial. It added to the argand penal test, informative non-penal tests for flat-flame value and calorific power.

In 1909, the Gas Light and Coke Company had imposed upon them a penal calorific test—in addition to the penal argand test, while the non-penal flat-flame test was continued. The Gas Light and Coke Company thus became not only the sole Company to have the penal calorific standard, but also the only Company to have a double standard to work to—*i.e.*, illuminating power and calorific power.

There followed the South Suburban Gas Company's Act of 1912, which continued for the whole area the non-penal flat-flame test and incandescent burner test which had been imposed by their Act of 1906, but substituted in a large part of the Company's area a penal calorific test for a penal argand test, leaving the former area with a non-penal argand and the remainder of the district with a non-penal calorific test.

In that year, the Wandsworth, Wimbledon, and Epsom Amalgamation Act received Royal Assent. In this case, a universal calorific standard with penalties was imposed, while the local authorities had the right to continue the argand burner test, but for information only.

Two smaller Companies—viz., Redcar and Porthcawl—also obtained the calorific standard for penalties with the argand burner test for information only; and finally, and most significantly, one local authority—*i.e.*, the Morley Corporation—asked for, and obtained, a calorific standard, and the repeal of their illuminating standard test.

The evidence seems to point to the fact that in several of these cases, the imposition of a calorific standard was due, not merely to the initiative of the companies but indeed to pressure by the local authorities, acting in what they considered to be the interest of the public.

This completes the list of undertakings working on a calorific standard up to the beginning of the present session. But the standard required, the method of carrying out tests, the amount of penalties and other details vary as between one company and another; and therefore a tabulated statement of these particulars is set out as an appendix.

Now in the present session of Parliament a great many applications have been made by promoters for the abolition of the illuminating test, and the substitution of a calorific test, almost all of which followed the South Suburban precedent without any modification, and without regard to the geographical situation, the present illuminating power, or the standard price of each particular company. Apparently it was thought, because the use of the No. 2 "Metropolitan" burner was authorized in almost all cases without any consequential financial adjustment, that a similar course of following a precedent (the South Suburban) could be taken with respect to calorific power.

Those who held this view appear to have overlooked the fact that the undoubted and indisputable justification for the use of the No. 2 "Metropolitan" burner was to put gas companies in possession of what the earlier legislative enactments intended to provide them with—*i.e.*, the most suitable means for testing the illuminating power of the gas. A little thought will show that the selection of a suitable calorific standard for each gas company may possibly be held to rest on a different basis, and does not necessarily entail uniformity; and from the decision of

Lord Clinton's Committee on the Gas Light and Coke Company's and the Liverpool Gas Company's Bills, it is apparent that the settlement of an adequate calorific standard for each gas company will be considered separately by Parliamentary Committees—each case on its own merits. Further than this, it is an open secret that this is the view held and expressed by the Board of Trade.

It will be gathered from the context that at the moment when this is written two important decisions have been arrived at—viz., the Gas Light and Coke Company and the Liverpool Gas Company; and it may be appropriate to congratulate the immediate past and the reigning Presidents of the Institution on being largely responsible for a decision which it is felt will be to the lasting advantage of gas consumers and the gas industry. Incidentally, it is worthy of note that, perhaps for the first time, a company outside London has been in the forefront of a fight by which the interests of the whole industry will be vitally affected.

The decisions on the two Bills referred to are briefly as follows:

1.—Gas Light and Coke Company.

*Calorific Power.*

(*a*) Daily test with penalties.
(*b*) Standard of 540 B.Th.U. gross.
(*c*) If the test on any day is more than 7½ per cent. below standard, a second test, after notice, to be made; the average to represent the calorific power for that day.
(*d*) No penalties unless calorific power is less than standard by more than 7½ per cent.
(*e*) Apparatus to be employed and tests to be made in such a way as to obtain the total heat value from the gas.
(*f*) Apparatus to be prescribed by Metropolitan Gas Referees subject to appeal by Gas Company.

*Illuminating Power.*

(*a*) Argand burner test abolished altogether.
(*b*) Flat-flame test for information only.
(*c*) No standard of illuminating power specified to be yielded by the flat-flame burner.

2.—Liverpool Gas Company.

*Calorific Power.*

(*a*) Daily test with penalties.
(*b*) Standard of 550 B.Th.U. gross.
(*c*) If the test on any day is more than 5 per cent. below standard a second test, after notice, to be made; the average to represent the calorific power for that day.
(*d*) No penalties unless calorific power is less than standard by more than 5 per cent.
(*e*) Apparatus to be employed and tests to be made in such a way as to obtain the total heat value from the gas.
(*f*) Apparatus to be agreed between Local Authority and Company; failing agreement, appeal to Board of Trade.

*Illuminating Power.*

(*a*) Argand burner test abolished altogether.
(*b*) Flat-flame test for information only.
(*c*) No standard of illuminating power specified to be yielded by the flat-flame burner.

*Pressure.*

Minimum pressure, 12/10ths.

If the decision in these two Bills is compared with the particulars tabulated in the Appendix, the following material alterations will be observed:

1.—The sweeping away altogether of any standard of illuminating power and of the argand burner test.

APPENDIX.—*Gas Authorities with Calorific Tests Prior to Parliamentary Session of* 1914.

| Name of Authority. | South Staffordshire (Mond Gas) Company. | London Gas Act, Gas Light and Coke Company, South Metropolitan Gas Company, Commercial Gas Company. | South Suburban Gas Company. | Gas Light and Coke Company. | Wandsworth, Wimbledon, and Epsom District Gas Company. | South Suburban Gas Company. | Porthcawl Gas Company. | Redcar, Coatham, &c., Gas Company. | Morley Corporation. |
|---|---|---|---|---|---|---|---|---|---|
| Date of Act . | 1901 | 1905 | 1906 | 1909 | 1912 | 1912 | 1913 | 1913 | 1913 |
| Calorific standard. | 125 B.Th.U. at 32° F. and 30 in. mercury. Products cooled to 60° F. | None specified. Test for information. | None specified. Test for information. | 125 calories net | 136 calories gross | 540 B.Th.U. gross | 540 B.Th.U. gross | 125 calories net | As South Suburban 1912 |
| Penalty point . | If below standard | .. | .. | 112½ calories net | 122 calories gross | 475 B.Th.U. gross | 475 B.Th.U. gross | 112 calories net | Do. |
| Daily test . . | Daily test | .. | .. | One test. Average with second test if first is below 112½ calories | One test. Average with second test if first is below 115 calories | One test. Average with second test if first is below 447 B.Th.U. | One test. Average with second test if first is below 447 B.Th.U. | One test. Average with second test if first is below 112 calories | Do. |
| Averaging . . | None | .. | .. | If not more than 6 below 112½ calories, average with preceding and following days | If not more than 7 below 122 calories average with two following days | If not more than 28 below 475 B.Th.U. average with two following days | If not more than 28 below 475 B.Th.U. average with two following days | If not more than 7 below 112 calories average with two following days | Do. |
| Penalties . . | £20 | None. Test for information | None. Test for information | Not exceeding 3 calories, £5. Between 3 and 6 calories, not exceeding £10. Each 6 calories not less than £25 and not more than £100 | Not exceeding 3½ calories, £2. Between 3½ and 7 calories, not exceeding £5. Each 7 calories not exceeding £10 | Not exceeding 14 B.Th.U., £2. Between 14 and 28 B.Th.U., not exceeding £5. Each 28 B.Th.U. not exceeding £10 | Not exceeding 14 B.Th.U., 10s. Between 14 and 28 B.Th.U., not exceeding 20s. Each 28 B.Th.U., not exceeding 40s. | Not exceeding 3½ calories, £2. Between 3½ and 7 calories, not exceeding £5. Each 7 calories, not exceeding £10 | Do. |
| Argand burner tests. | None | Penal test | Penal test 14 candles No. 2 "Met." | 14 candles No. 2 "Met." Penalties for defect | 14 candles No. 2 "Met." No penalties | 14 candles No. 2 "Met." No penalties | None | 12 candles No. 2 "Met." No penalties | None. Previous c.p. repealed |
| Other tests . . | Carbon monoxide not to exceed 14 per cent. | Flat-flame test for information | Flat-flame test and incandescent burner test for information | Flat-flame test for information | None | Flat-flame test and incandescent burner test for information | None | None | None |
| Remarks . . | Several Power Acts have followed this Act | Gas Light and Coke Company testing provisions modified by 1909 Act | Modified for large part of district by Act of 1912 | Provisions as to West Ham district different in details | .. | Act of 1906 still to apply to part of district | Observe that penalties are smaller for this smaller Company | .. | .. |

2.—The establishment with the penal calorific test of a non-penal flat-flame test for information.

3.—The abolition of a gas company's right to average the calorific tests for three days before being penalized. In other words, a gas company must stand or fall by the calorific test on one day; although a second must be taken and averaged with the first if this is below the penal point.

4.—The lessening of the margin between the standard of calorific power and the penal point—leaving in one case 40 B.Th.U. and in the other case only 27.

5.—The establishment of a gas company's right to have the test made by such apparatus and in such manner as to yield the gross total heat value of the gas. This latter is an important step; and it is satisfactory to note that the logical position of those who have advocated this right, has been accepted by the Parliamentary Committees.

With respect to the imposition of a non-penal flat-flame test, the author is disposed to think that this will prove to be but a temporary provision, which will be swept away when sufficient evidence is forthcoming that the flat-flame consumer has approached the distinction of a Dodo and become extinct. This no doubt lies to a great extent in the hands of gas undertakings, for surely the abolition of such uneconomical things as flat-flame burners will rest on their efforts to substitute a more economical form of lighting.

It should here be pointed out that, as the steady burning of a flat-flame burner depends upon proper conditions, care should be taken by companies that suitable arrangements are made when photometers, hitherto used with an argand burner, are being converted for use with the flat-flame.

Attention is directed to the increase in minimum pressure inserted in the Liverpool Bill. This will no doubt be found to be the forerunner of similar clauses in other Bills; and it is therefore of importance to gas authorities that their distribution systems are carefully investigated and overhauled in view of future possibilities.

In this connection the author would refer to a view he has expressed before this Institution on a previous occasion—viz., that there is more value in a cubic foot of gas at a higher pressure than there is at a lower pressure. It follows that if it is sought to impose a higher standard of pressure upon a gas authority, this fact, as well as the fact that higher pressure means increased unaccounted-for gas, should be placed before Committees, with a view to obtaining a corresponding equivalent in the standard price.

In view of what has been stated—viz., that it is the evident intention of the Parliamentary Committees to consider the fixing of a calorific standard separately, each gas undertaking according to local circumstances—the author ventures to think that the following facts emerge:

Firstly. The needs of each district must be carefully studied by those responsible for the gas supply, and it must be ascertained by experiment what figure would be the ideal one for a calorific standard for such district.

Secondly. The possible yield in heat units from all sources of coal supply (and other gas-making materials) which appear to be purchasable by the gas authority on financial grounds should be carefully investigated.

Thirdly. The influence upon calorific power of all possibly available methods of carbonizing should be similarly considered.

The bearing that these three factors will no doubt have upon the decision of future Committees in the matter of a calorific standard is to obtain a suitable figure for a calorific standard, to ensure a margin between the standard and the penal point sufficient to cover possible variations in the calorific power of gas, and to keep open and unrestricted the bargaining power of a gas undertaking both in respect to carbonizing materials and plant.

There appears to be little possibility of the expression of calorific power in terms of gross British thermal units being departed from, nor does there seem to be any likelihood of any objection being forthcoming to the principle that a gas authority is entitled to the total heat value in the gas. These matters are, of course, questions which depend upon the drafting of suitable clauses.

It seems to the author that before a gas company comes to Parliament, it should arm itself with information on the above lines; and it is highly desirable that care should be taken to frame clauses which will enable the local authority and the gas company to carry on tests without friction, and in a manner which is not detrimental to the interests of the gas consumer, and therefore of the gas undertaking.

The author thinks it would be to the advantage of the industry if the Institution took into consideration the possibilities from every point of view of the supply of cheap power gas, alongside with the normal supply of gas of standard calorific power.

## DISCUSSION.

The PRESIDENT: Ladies and gentlemen, with your permission, I propose to open the discussion on this paper; and if I exceed the allotted two minutes, I hope you will forgive me. But this paper is one in which Liverpool has been so particularly interested that I thought it best I should make notes upon it, which I will read to you for the purpose of saving time. The subject has been the most prominent one during the past year; and the conference would have been greatly lacking in the absence of Mr. Abady's paper. We are fortunate in having him for the author, beause no one has a better and more complete knowledge of the subject. Some reference has been made in the paper to the need for varying the standard to suit the special circumstances of each undertaking; and the cases of the Gas Light and Coke Company and the Liverpool Gas Company are given as instances. The case of Liverpool is quite exceptional, because it involves a very great reduction in the grade of gas to be in future supplied to the consumers; and hence the limitation imposed by the Committee of the House of Lords. In my opinion, however, the ideal to be sought is a uniform quality of gas throughout the country, which would enable maximum efficiencies to be obtained from standard gas appliances. For this reason, it would be better for the standard calorific power to be the same for every undertaking. The figure fixed for the Gas Light and Coke Company's gas is 540 B.Th.U. gross, with a margin of 7½ per cent. before reaching the penalty line—viz., 499·5 B.Th.U. gross—while for Liverpool it is 550 B.Th.U., with a margin of 5 per cent., which fixes the penalty figure at 522·5 B.Th.U. These conditions have been accepted; but it is not advisable they should be followed by other undertakings, for the following reasons. I have a letter here which I have received from our friend Mr. Shadbolt, whose absence during this session has been a great loss to us. He is at the present time in London concerned about some Bill, and has been dealing particularly with this question of calorific value. After referring to some personal matter, he writes to say: "You would possibly like a line respecting to-day's interview with the Lord Chairman. Briefly, he agrees that the Liverpool calorific standard shall not be taken as a precedent for other provincial undertakings. He seems inclined to give us the 500 B.Th.U. standard we asked for, but does not seem quite so ready to allow the 5 per cent. margin off that. He agrees there may be circumstances warranting the 5 per cent., or even more, but seems to think that, on the other hand, there are cases where more than the 500 B.Th.U. would be justified." I pressed Mr. Shadbolt to get the 5 per cent. off 500 B.Th.U.; and then I said you and the industry will be in a very good position. In the first place, the penalty figure is so high as to limit the power of an undertaking in its desire to supply the maximum of heat units for 1d.; and, in the second place, the margin of 5 per cent., or 27·5 B.Th.U., is not sufficient for practical working. On looking over the records at our Linacre works, I found that during the eight months ending March last there was a range in the gas distributed of 46 B.Th.U. in the monthly averages, or 7 per cent. It is admitted that during this period there was no attempt at all to supply gas of a uniform calorific power, and regard was only paid to illuminating power. But even with special attention it would, in my opinion, be impossible to work within a margin of 27½ B.Th.U. It is not possible to obtain uniform calorific figures from various classes of coal; and I find that in tests made at the Linacre experimental works between August, 1912, and March, 1914, with nineteen samples of coal (each about 80 tons), the calorific powers varied from 547·83 B.Th.U. gross to 689·72 B.Th.U., giving a margin of 141·89 B.Th.U., or 26 per cent. Incidentally, it may be stated that the illuminating power in No. 7 batswing burners varied from 10·72 to

13·86 candles, giving a margin of 3·14 candles, or 33 per cent. It may be argued that it is usual to make contracts for large quantities of particular coals, and thus no such variation as the before-mentioned would be likely to occur; but in reply I am quite sure that in ordinary working 5 per cent. would be an inadequate margin. With carburetted water gas the range of calorific power is much smaller; and in 28 samples the minimum was 548·02 B.Th.U., and the maximum 581·40 B.Th.U., giving a margin of 33·38 B.Th.U., or a difference of 5·8 per cent. The illuminating power ranged from 14·02 to 20·08 candles in the No. 7 batswing burner, giving a margin of 6·06 candles, or a difference of 30·2 per cent. In these tests, the gas was purified by oxide and lime, so that all the $CO_2$ was removed from the gas. In the case of 31 tests with oxide only used for purification, and the gas containing 2 to 3 per cent. of $CO_2$, the range of calorific power was from 572·22 to 560·82 B.Th.U., or 11·4 B.Th.U.—say, 2 per cent. The illuminating power ranged from 17·45 to 14·42 candles in the No. 7 batswing burner, equal to 3·03 candles, or 17·3 per cent. It is remarkable that, although the illuminating power of the gas was increased from 14·42 to 17·45 candles, the calorific power was only increased by 11 B.Th.U. I fear that this interesting subject has led me to occupy a great deal of valuable time; but I hope that the endeavour to show the necessity of fixing a uniform standard for calorific power, with a reasonable margin to meet the practical requirements of gas manufacture, has received the approval of this very important meeting.

Mr. George Helps (Nuneaton): Parliament is supposed to look after the interests of the consumer; but so far as I understand it, it seems to me that Parliament is engaged in finding a very easy livelihood for a good many people in promoting Bills, the cost of which is paid in the first place by the promoters, and next by the consumers. Why is it that gas producers should be trammelled with all sorts of clauses, because the purveyors of other goods are not? If the beef consumers cannot find what they require in one market, they go to another; but we know that, in so far as gas is concerned, it is a monopoly. Mr. Abady very naively told us that the more quickly we travelled to a place the sooner we arrived there; and it seemed to me that the chief point in his paper was at the end of it, and that we should have got there sooner if we had started at the end. As I read it, there is something in having, not only one line of communication, but two. For my part, I would sooner increase the pressure, and use one. I refer to the clause of the paper which says: "The author thinks it would be to the advantage of the industry if the Institution took into consideration the possibilities from every point of view of the supply of cheap power gas, alongside the normal supply of standard calorific power." What, in all conscience, do we want with a gas of 500 B.Th.U.? Does the consumer use it of that quality? No. He dilutes it down to 100 B.Th.U. Have we realized this? I do not think we have, because if we had I cannot believe that there are so few men who would agree that something like 300 B.Th.U. is quite enough for anybody. I should like some consideration to be given to this point. I know it is a great drop from 500 B.Th.U.; but surely we shall have to get down to it. What does the consumer want? If we are going to give him 300 B.Th.U., we cannot expect him to pay the same price for it as he would for 500 B.Th.U. I think this is a point of the utmost importance. Then, if we got down to this point, we should not be talking about sending out two grades of gas. What do we want a high-grade gas for? It is simply wasting good stuff, because no one wants it.

The President: I think we should all like to hear what Dr. Elliott has to say.

Dr. A. H. Elliott (New York): Mr. President, it is very kind of you to call upon me. You will be interested to learn that we are troubled with the same question in New York; but we have not succeeded in getting as far as you have. In the State of New York we have still a Public Service Commission considering this very important point of providing the present illuminating gas with a calorific power standard. I cannot help noting the remarks of the last speaker with regard to sending out two kinds of gas. No matter whether we have calorific power or photometric, it seems to me that we ought to look out for the lines of work followed by our electrical friends. The distribution of gas is a very important item; and it is to our interest, I think, to send out, if possible, either a higher pressure or higher quality of gas. Now, I may be throwing in a shell among you here which may burst; but I thought seriously, as the last speaker was talking, whether he was not going away from really economic and efficient distribution. The electric light people, of course, as you know, distribute over great distances high-tension currents. In certain lines of work, we must have high pressure, if we are going to get good light. This goes without saying. In my opinion, we should not send out diluted gas. The late George Westinghouse conceived a project for making the gas at the mines, and sending it through pipes at 100 lbs. pressure. The Legislatures of the various States interfered with it, and would not give them a franchise. I would also say in this connection, with regard to heat, that we must look after the consumer, and teach him to look after his own house, and take care of the whole of his energy. I had a conversation some time ago with a gas manager, and suggested to him that, if some of our schemes were carried out, he would need to supply four times the gas *per capita*. The gentleman held up his hands in horror, and said: "Good heavens, man, I cannot get out enough gas now." I said that is not up to me. The point is what the consumer wants. The ideal thing is to send the gas to a man, and let him use it in his house for whatever purposes he wishes. Just think of the number of times the coal has to be handled. It is awfully wasted; and the only way is to get gas into the house so that everybody can use it easily.

Mr. W. Grafton (Glasgow): Mr. President, it is not possible to discuss this paper adequately in the allotted space of two minutes. They are tying the Gas Light and Coke Company down to 540 B.Th.U.; but it seems to me that we are not getting the full advantage to-day in being tied down to this figure. Therefore, I would say that the maximum value should be 490 B.Th.U. for those purveyors of gas who send out neat coal gas; and for those who send out carburetted water-gas mixtures it should be 460 B.Th.U. There should be no margin. Taking the figure of 540 B.Th.U., the consumer finds that he is only getting 520 B.Th.U.; and my point is that, if it were 490 B.Th.U., you would have your up-and-down movement, and you can deal with it in that way, and as soon as you get to 490 B.Th.U. you can put on your penal clause. If I go to a grocer to buy a pound of tea, he is not allowed such a margin as 5 per cent. up and down. He has to supply a pound of tea. Coming to the last portion of the paper, I should like to know what Mr. Abady means when he speaks about the abolition of the gas company's right to average the calorific tests for three days before being penalized. There is a difficulty in complying with the present Act as it stands on any day of the week, whether it is Monday or any other day. With regard to the gas going out, I do not think any one of us is desirous of sending out blue gas. If the mantle should break, we can get luminosity by shutting off the air. With regard to pressure, I do not think we should gain much by increased pressure. Flat-flame burners lose all the property of giving light when the pressure is raised.

Mr. John Bond (Southport): It struck me that the first thing the industry should consider is the standardization of the calorimeter. We find that these calorimeters give varying results; and I think the ideal standard to work to is 500 B.Th.U., with a limit of 5 per cent.

Mr. E. W. Smith (Birmingham): Mr. Bond has anticipated what I wanted to say. I was going to suggest the advisability of appointing a Committee to lay down what should be the conditions of testing; and I hope this will receive consideration. It is not necessary for me now to go into the possibilities of getting wrong or mistaken results, or being tempted to take calorimeters which gave high results, or working with calorimeters in a low-temperature room or a high-temperature room—all those things which affect the calorific value very much. I defy anyone to get results which are consistently comparable. If they do get them, it is by a pure fluke. I strongly concur with the President in his request for a standard calorific value. I agree with Mr. Abady on one point—that different districts require different calorific values only in one respect, and that is that they have in various districts different elevations. The point is that the gas, after it has left the jet, should be of a standard value.

In Birmingham, we have to supply a gas of high calorific value to get the same results as you have in London. I think that is the only case in which you can consistently have a different calorific value. One cannot agree with Mr. Helps at all in his request for a low-grade gas. Dr. Elliott has dealt with this point. If it is necessary to dilute the gas, let the consumer do it. He cannot enrich it, but he can reduce it.

Mr. J. Ferguson Bell (Derby): Mr. President, my only object in rising is to suggest that this is an opportune time for the Council to take into consideration, by the appointment of a Committee, the means of standardizing, not only the calorific value of gas, but the means of obtaining this value. I join with you in expressing my appreciation of the communication Mr. Abady has laid before us. He possesses very special knowledge of this subject. He pointed out in a very able way how, for a great number of years, difficulties were raised with respect to obtaining the illuminating power; and if we are not very careful, we shall have a great number of regulations. He has pointed out the enormous amount of difference that exists between different Bills; and, with all due respect to Mr. Abady, I would suggest that it would be desirable that we in this country should have one uniform standard with regard to calorific value. I think I voice the opinion of most here when I say that we do not object to reasonable regulations. We must remember that we have a monopoly in respect of the supply of town's gas; and therefore we ought to submit to some regulation. Mr. Helps's analogy is not quite correct. He says you can go to a tradesman and buy a certain article; but what he forgot to say was that you can go to a number of tradesmen, whereas if you want town's gas you have only one gas company to go to. There is one important point to be borne in mind, which is that the margin tests of calorific value and the penalty clause ought to be as wide as possible. I should like to know Mr. Abady's opinion on the question of whether it would be possible to obtain a three days' average in getting the test for illuminating power. If we had this, we could then go for a smaller margin. I join with you, Sir, in saying how pleased I am that this matter has been brought forward, because I think the time is inopportune for its consideration.

Mr. S. B. Langlands (Glasgow): The only point I should like to make, Sir, is that I think we should seriously consider Mr. Smith's suggestion as to the necessity for the appointment of a Committee to technically deal with the question of standardizing the test for calorific value. Mr. Abady spoke of the extraordinary complexity that one was met with when bringing things to a head. When Mr. Abady spoke of carefully investigating the possible yield in gas units from all sources of coal supply, I was rather wondering what he was getting at. I see very great difficulty in any serious reservation for a particular district, because, as Mr. Abady says, it would give a power to the supplier of the coal, which might be a very serious matter. We all of us know the value of having a big market.

The President: If any other member desires to contribute to the discussion, the technical papers will be glad to receive communications, or they may be sent to the Secretary, and will be made use of when publishing a report of the meeting. I must now call upon Mr. Abady to give us his reply.

Mr. Abady: Mr. President, if I do not reply to every point that has been raised by each individual speaker, I hope the particular speaker who has been unnoticed will not consider me discourteous, or that there are not lots of replies to the points he has raised. Of course, the essential thing is that which was raised by Mr. Allen—namely, the advisability of having a suitable standard for the whole country. My reply to that is, "Certainly, if there is enough margin in the calorific power that is fixed." That is the whole point, because it sounds very well—I say it with all respect to Mr. Allen—to dream of the idea of everybody supplying gas of the same calorific power all over the country. This may be all very well; but if you go into it from that point of view then I suggest that you want something more than calorific power to ensure that you are getting a constant quality. You could have a constant quality for the whole country if you have a sufficient margin. Mr. Helps made some humorous remarks with regard to what he considered the actual purpose of Parliamentary Committees; but I am sorry experience does not lead me to coincide with his views on this matter. Mr. Helps also referred to all sorts of clauses being imposed on gas companies, and said they were subject to all kinds of regulations; and he asked, "Why have any clauses at all?" Now, it is my view that, speaking generally, the arrangements under which gas authorities work—particularly if there is a standard price with a sliding-scale, and with outside testing by the local authority for quality—constitute as ideal a method of dealing with what necessarily must be a monopoly as anyone could conceive; and if these arrangements were in any way altered, it would be a bad thing. Mr. Helps then referred to the penultimate paragraph of my paper; but he did not deal with it in the way I intended. What I really mean is that the future lies, as I have heard Mr. Allen put it, with the man (never mind whether he is an electrician, oil merchant, or anything else) who can sell the greatest number of heat units for a penny. It seems to me that it might be economical, in some future decade or generation, to supply gas of a very much lower calorific value than one does at present, and thereby charge very much less per 1000 cubic feet, and in this way supply more heat units for a penny. When I say this, I want to point out to Mr. Helps that I do not mean you should dilute the present quality of the gas because the consumer uses air for its consumption. This appears to me capable of being described quite tersely as nonsense. What I mean is that it is conceivable that some method of gas manufacture might be arranged by which you might make combustible gas and supply it in such a way that 1000 cubic feet would contain less heat units than can now be supplied, at a much reduced price. Therefore, I make the suggestion that some pioneer may be found who will experiment, and see whether it would be possible, without, of course, interfering with the supply of the statutory gas, to supply this gas to certain consumers at a low figure. I do not mean Mond gas which is nearly all nitrogen, or anything of that kind. Between the view expressed by Mr. Helps and Dr. Elliott's view with respect to the economy of distribution, I think there is a great gulf fixed, because if you take Dr. Elliott's view it means that if you can supply gas at 5000 B.Th.U., you will be doing better than supplying it at 500 B.Th.U. This is the rock on which the high-power gas man has stood. But that rock has already been washed away here, and soon will be in the United States, because he has found that, in working in the direction of supplying more heat units for a penny, we are keeping down the standard quality of gas. I think it would be a bad thing to have a standard fixed, and then really supply less. I think I ought to say here that it was the intention of the Parliamentary Committees that the standard actually supplied should be the standard fixed, and that the 5 and 7½ per cent. should be the margin. If you have a fixed figure, and do not depart from it, I do not think it is fair to take the analogy of the Weights and Measures Act. I should rather take the Food and Drugs Act, whereby you must not put (say) any boracic into certain foods, but you may put a certain quantity. With respect to what Mr. Bond said as to standardizing the calorimeter, the same point was made by Mr. Smith, Mr. Bell, and Mr. Langlands; and it does appear the desire of the Institution that some work should be done in this direction. I quite agree with Mr. Smith that, under present conditions, the coincidence of two calorific tests is one of those happy circumstances which only occur in three-volume novels or Adelphi melodramas; but that is purely a domestic matter for the Institution, with which I do not feel called upon now to deal. I do not myself see any great difficulty in standardization; and I hope that the work I have done in the matter may perhaps contribute towards this end, because it is a conception I have had for several years, and I was going to say it is the lyre that I have been playing upon all along. Then Mr. Bell asked about a three days' average; but I think that is gone, unless the margin is lessened. The Board of Trade deal with it in a memorandum that I have here, and incidentally speak against a three days' tests if the margin is continued. I do not think that there are any other material points with which I am called upon to deal, except to thank you, Sir, for the kind way you referred to me, and the members present for their appreciation of my paper.

The President: I may state that it is proposed to take up this question of the standardization of the calorimeter;

and we should be glad to have the advantage of any assistance Mr. Abady can give us.

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Mr. A. E. Broadberry (Tottenham) writes, under date of the 19th inst.: At the meeting yesterday the discussion was cut short by the President, who stated that any further contributions to it might be sent to the Technical Papers direct. I enclose some remarks I was prevented making.

I believe it will interest the members to know that at Tottenham, although we are not working under any calorific clause in any of our Acts of Parliament, for the last eight years we have been working under a calorific standard agreed with the Urban District Councils by a private arrangement, on which they withdrew their opposition to our 1906 Act. Our standard is a very simple one, with no margin in which we may be below the standard, but are not to be penalized; and, when examined, our standard will be found to correspond fairly well with the penal point to which most of the companies now working to calorific standards are submitted —namely, a net calorific standard of 450 B.Th.U.

I do not suggest that the net calorific is by any means the correct one—in fact I hold the opposite idea, and consider that the gross value is the one which should always be stated. The members will all know that 450 B.Th.U. net corresponds almost exactly with 500 B.Th.U. gross; and this, in turn, almost exactly corresponds with all the recently adopted standards.

It will further interest the members when I state that, during the whole eight years, we have had no difficulty in maintaining the standard with many different classes of coal; and during the eight years we have gradually increased our yield of gas per ton, year by year, until we are now making over 13,000 cubic feet of 14-candle gas of a gross calorific value of 540 B.Th.U. It naturally follows that having to work by a dual standard is more difficult than having to work by a single one; and those companies who may be contemplating exchanging illuminating power standard for calorific need have no hesitation in accepting any figure of this description—especially without any hampering by the illuminating power restrictions as well as the heating value.

# THE APPLICATION OF COKE-OVEN CARBONIZING AND "OTTO" DIRECT AMMONIA RECOVERY TO GAS-WORKS REQUIREMENTS.

**By GEORGE THOMSON PURVES, A.M.Inst.C.E., of the Auchengeich Coke-Ovens, Chryston.**

**Member of the Scottish Junior Gas Association (Western Section).**

In accepting a paper from a member of a Junior Association, the Council of the Institution have given recognition which will be highly appreciated by all such Associations, and particularly so by that of the Scottish Western District, in that the first paper should be from one of their number. It is the earnest hope of the author (who appreciates very much the honour done him) that it will justify the departure which has been made.

## Gas-Making Development.

Apart from cheaper methods of operating, the outstanding feature in the development of modern gas-works carbonizing practice has been the increase in the volume of gas made per ton, largely due to the application of higher heats. A considerable proportion, however, of the increase is probably due to more thorough carbonizing at the end of the carbonizing period; for the change in composition of the gas is hardly of the same order of magnitude as is suggested by the increase from the old 5000 cubic feet to the modern 12,000 cubic feet per ton. It is to a considerable extent dilution with the end carbonizing gases. Apart from better carbonizing, higher heat, with increased yield, has been the means adopted towards a lower price per 1000 cubic feet.

## Coke-Making Development.

In coke-making development the better financial position which has been achieved has been arrived at by improved bye-product production, and a larger production of coke has at the same time been obtained. Heavier charges have played a part in gas-making progress, and coke-oven carbonizing is the ultimate end of such practice. Since the common aim of these parallel industries is an increased financial return per ton of coal and per pound of invested capital, it should be interesting to examine how far modern coking practice with "Otto" direct recovery along lines of more valuable bye-product return is applicable and suitable to gas-making requirements. It may be noted that the working of intermittent verticals and top-charged coke-ovens has a good deal in common.

## Coke-Production.

In oven carbonizing, a large, hard, homogeneous coke is produced. To obtain this, the suitably selected coking drosses are crushed to a fine meal in disintegrators; and the moisture content is brought to from 8 to 12 per cent., and even more, depending on the coal and the ideas of the carbonizer. The size and hardness of the coke are primarly dependent on the coking qualities of the coal, but are also affected by the stamping of the charge, moisture, temperature of carbonizing, and time of carbonizing. At the higher temperature following the period of low temperature carbonizing, the volatilized products passing through the coke mass are partly broken up; and it is the carbon deposited at this stage which produces the hardness of the coke, and also the white colour which is taken so much care of in the quenching. On lowering the temperature for several hours from about the eleventh or twelth hour, the author has found the coke produced to be very brittle and of poor colour. Too high temperature results in hard coke but smaller in size. Low temperature gives blacker and softer coke, but larger pieces. The author has found a change of 30° C. make a distinct difference in the nature of the coke. The moisture modifies the decompositions of the volatile products, and retards the distillation by lowering the temperature; and it is probably in this way that too much moisture produces a softer and blacker coke. A certain amount of moisture is, however, necessary for the best quality. High volatile matter in the coal tends to produce light porous coke, and stamping counteracts this. When the temperature has just passed the coking period (the low temperature carbonizing period) the coke is relatively soft, as may be seen from the low temperature product, and is easily broken up. For this reason, the author does not view with favour the movement of the coke in continuous working verticals.

A photograph of a battery of "Otto" ovens, showing the coke car and the mechanical quenchers, is reproduced in fig. 1 (p. 949).

## Coke-Yield.

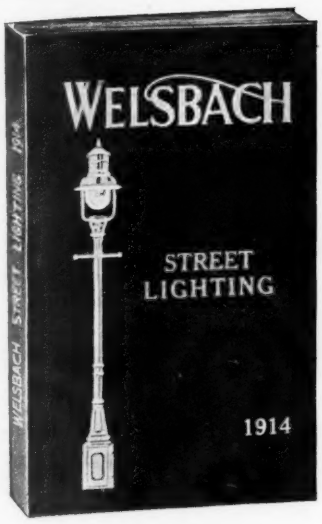
The yield of coke depends on the nature of the coal. The author obtained last year 78·75 per cent. on dry coal, made up as follows:

| | Per Cent. |
|---|---|
| Large coke | 94·14 |
| Nuts | 3·19 |
| Breeze | 2·67 |
| | 100·00 |

The moisture varies from a trace up to 2 per cent., and generally runs about 1 per cent. The actual greater selling price of this coke for the year June 1, 1912, to May 31, 1913, over that of gas-works coke at Glasgow was 7s. 0·4d. per ton of coke.

## "Otto" Regenerator Oven.

This oven (sectional views of which are given in fig. 2 appended) is built on arches in order to allow of the easy approach and thorough inspection of the various gas and air regulating appliances. In this case, the gas, after leaving the bye-product plant, is returned to the ovens along a central gas-main in the middle gallery shown on drawing.

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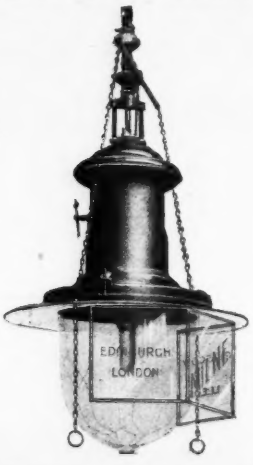


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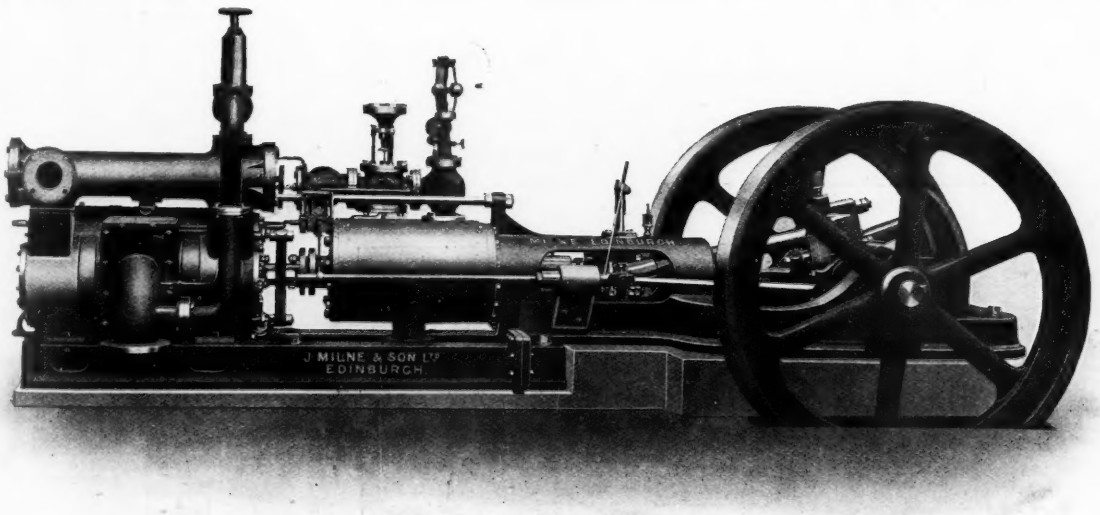


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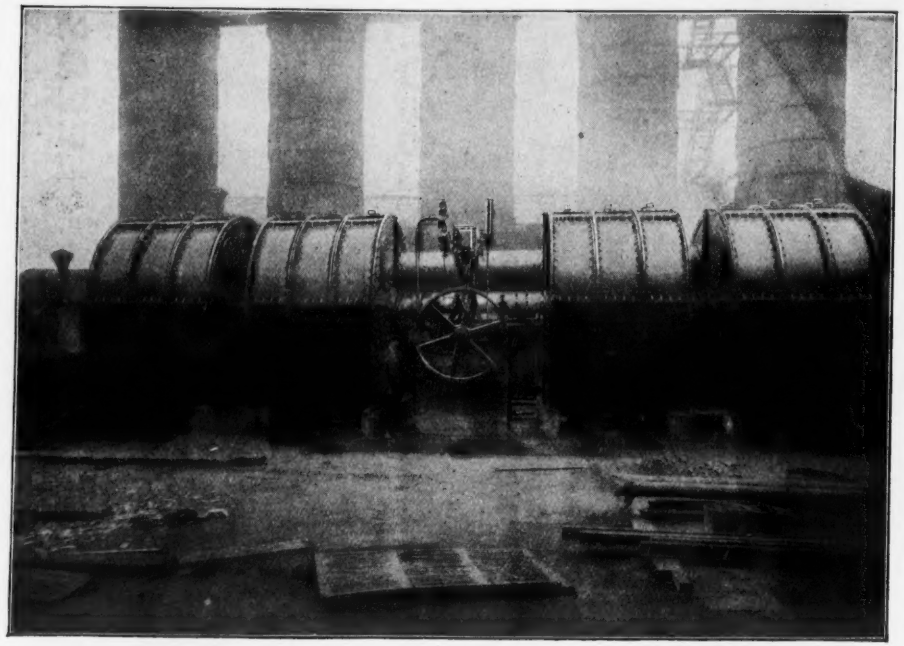

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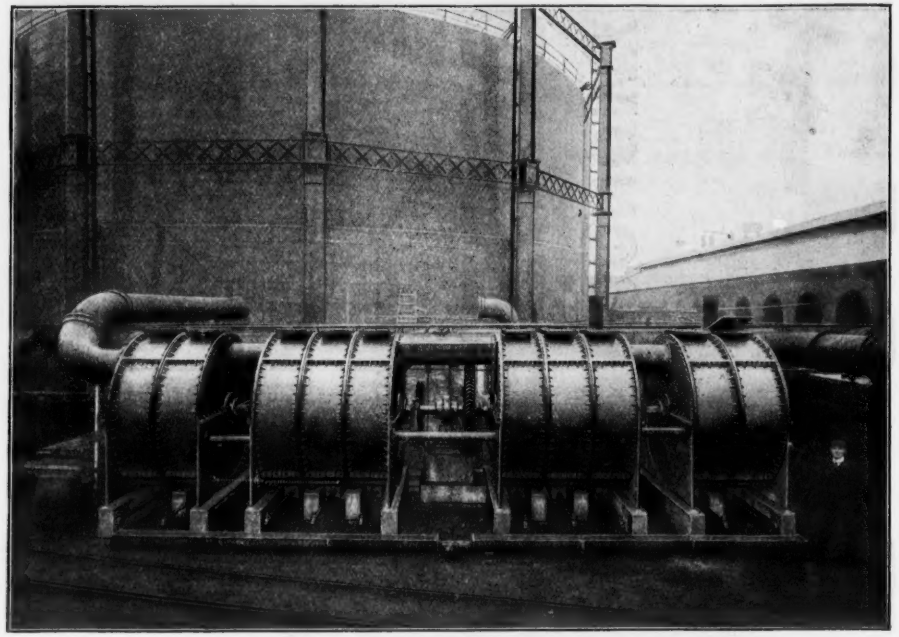

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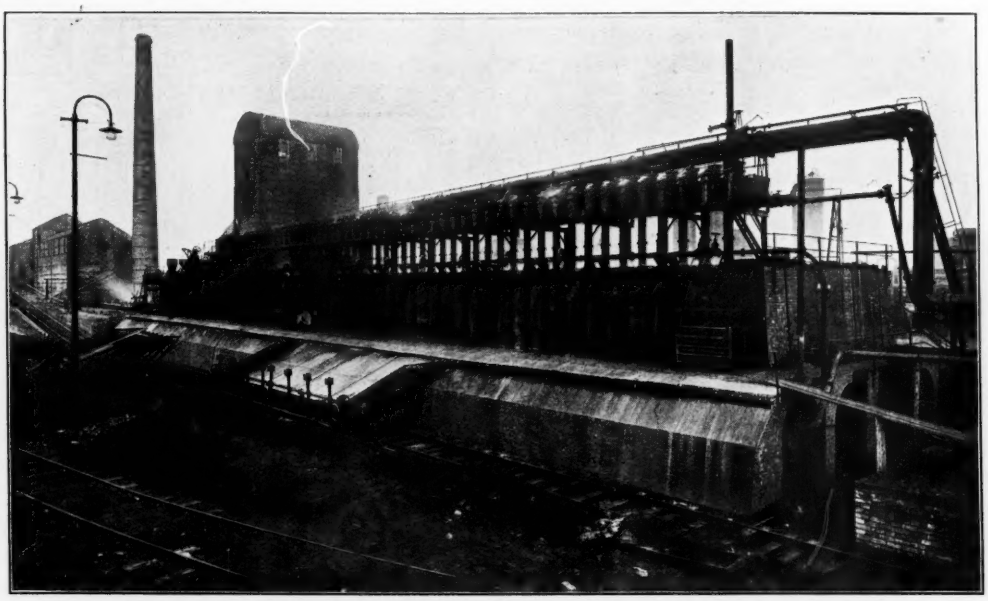
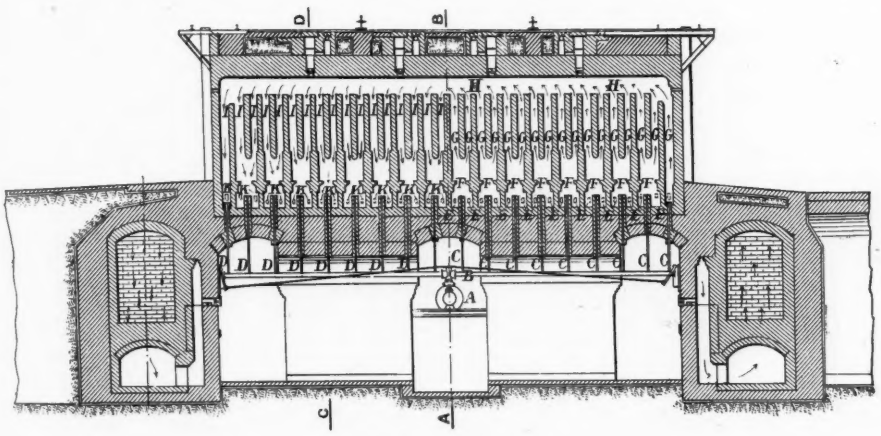
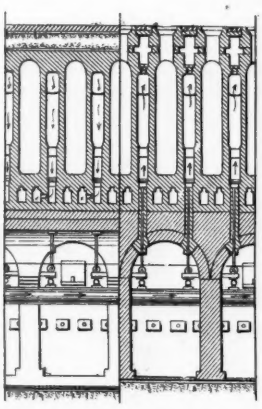


Fig. 1.—BATTERY OF OTTO OVENS, SHOWING COKE CAR AND MECHANICAL QUENCHER.

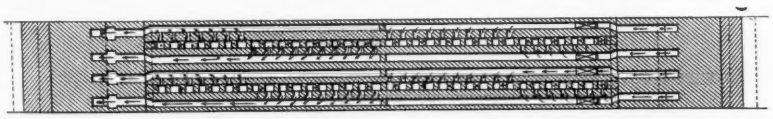
The gas passes along the distributing pipes running along the right-hand half of the ovens. From these pipes, it is distributed through the rising branch pipes, by which it ascends into the combustion flues, and mixes there with the preheated air, entering at port-holes, and burns approximately at the foot of the vertical flues of the ovens. The cold air enters through a port-hole, passes down the annular space, into the bottom of the regenerators, and rises through the regenerators. The hot products of combustion ascend the vertical flues in the oven wall, and enter the horizontal inspection flue at the top. They descend the vertical flues on the left-hand half of the oven, passing out of the bottom of these flues through port-holes, whence they pass through the regenerator, heating-up the brickwork as they descend,



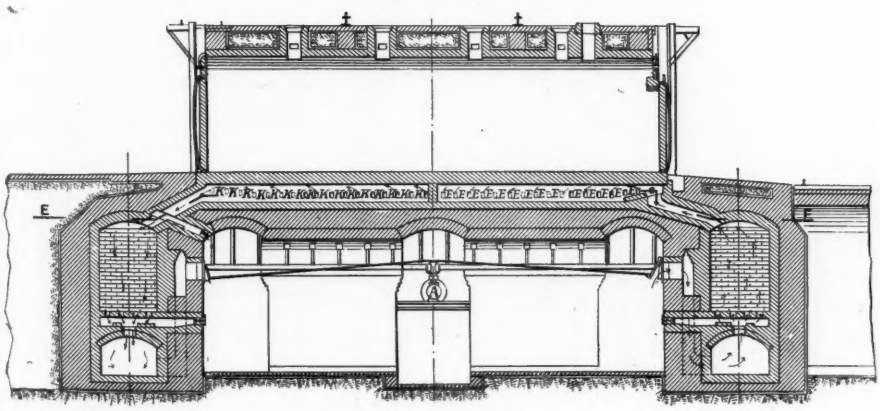
Section through Oven Wall.



Section on Line A B. Section on Line C D.



Section on Line E F.



Section through Oven.

Fig. 2.—"OTTO" REGENERATOR OVEN.

and flow away through the bottom channel into the chimney. By this means, the temperature of the hot products of combustion is reduced from approximately 1150° C. down to 250° to 300° C. before they pass into the chimney.

After thus working for a given period (say, twenty minutes or half-an-hour), the gas is cut-off, the air reversed, and the whole process of the heating of the ovens proceeds in exactly the opposite direction.

With normal coking coal having a moisture content of 10 to 12 per cent., 50 to 60 per cent. of spare coal gas is obtained for purposes other than the heating of the ovens. A battery of ovens of this design is being erected at the present moment at the

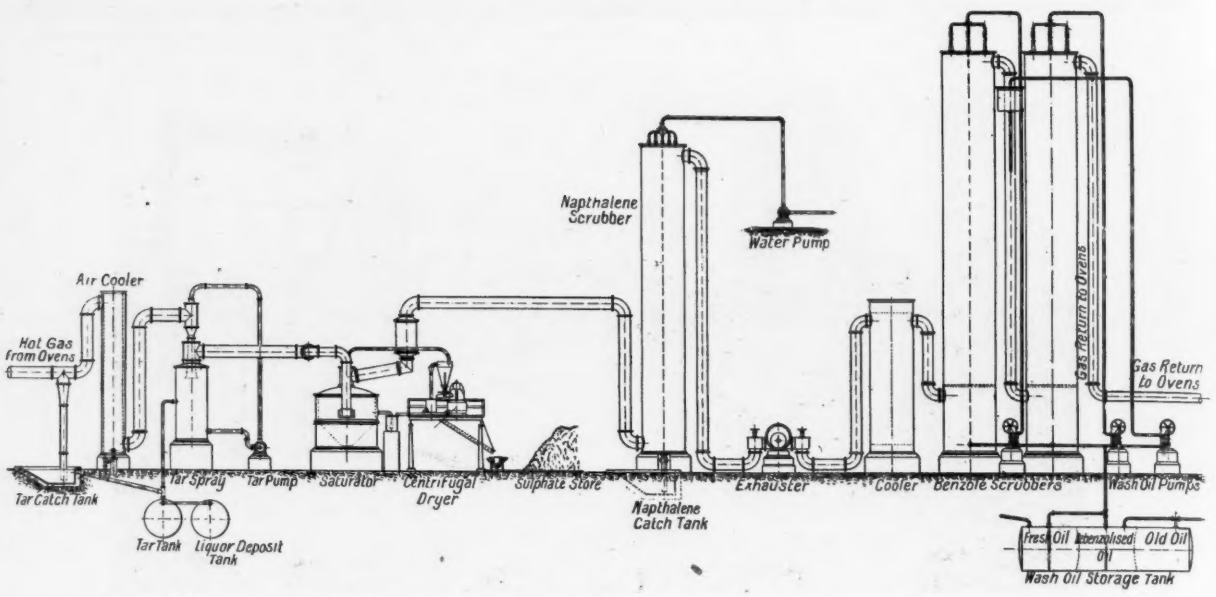



Fig. 3.—THE OTTO PROCESS FOR THE DIRECT RECOVERY OF AMMONIA AND THE RECOVERY OF BENZOL.

Newport Iron Works, belonging to Sir B. Samuelson and Co., Limited, which will supply the town of Middlesbrough with gas for lighting purposes.

### Products of Distillation.

Referring to fig. 3, the products of distillation are taken by ascension-pipes into the collecting main; no dip-pipes being used. The ovens are isolated by means of disc-valves. The crude gases in the collecting main at a temperature of 250° to 300° C. are taken by a gently rising foul main to one unit of an annular air-cooler, and then into the tar-extraction plant. They are partly cooled in the foul main and collecting main by atmospheric conditions exter-

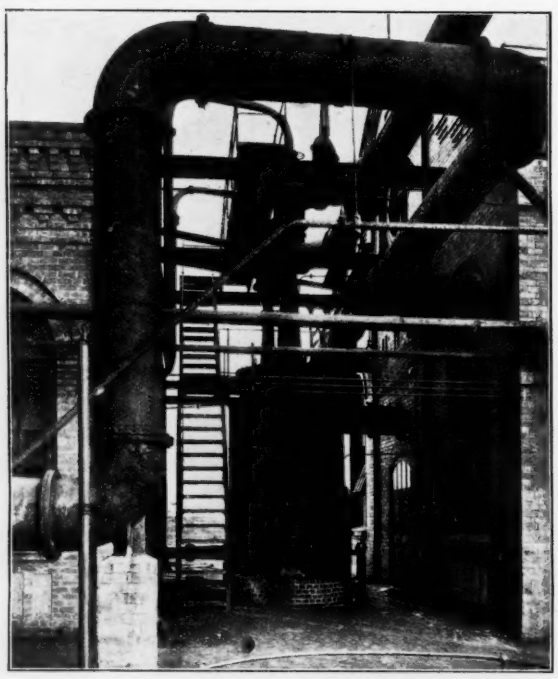


Fig. 4.—Tar Sprays for Dealing with the Gases from 350 Tons of Washed Coal per Twenty-Four Hours.

nally, and by a counter-current and controllable flow of ammoniacal liquor internally. Some of the heavier tar is thus separated out, and flows very hot with the liquor down the foul main and through the collecting main, dissolving in its course any pitch deposits. The amount of pitch still to be scraped out in 24 hours from a sixty-oven main is about ten to twenty pails full. However gradual or sudden has been the cooling, the gas must enter the tar-extraction plant at a temperature not lower than the dew-point. This is easily achieved. Assume that the gas in the particular case considered has been cooled to the dew-point—the dew-point is, of course, variable—all the tar oils which the gas cannot carry by saturation as true vapours will be present as tar-fog, and so can be removed by frictional means. The crude gas enters the tar-extraction plant and passes down the contracted neck, down which a jet of ammoniacal liquor is also being forced at an issuing pressure of 90 lbs. per square inch.

### "Otto" Spray Tar Extractor.

The "Otto" spray tar extractor (fig. 4) is a very simple but extremely efficient piece of plant. The essential part in which the tar extraction takes place is a vertical cast-iron pipe, some 6 to 8 feet long, narrower at the top than at the bottom. The dimensions are carefully determined for the particular liquor jet which is to be used. It is the passage of the particles of liquor through the gas at very high velocity, and in such a manner that no gas can pass untreated, that effects the tar extraction. This apparatus is mounted on the collecting and settling tank, and the liquor circulation is performed by a "Weise and Monski" centrifugal pump direct-coupled to an electric motor. The liquor spray exactly fits the contracted pipe, and acts to some extent as an exhauster. The fine globules of liquor beat out the tar by bursting the tar envelopes just as does the frictional contact in long condenser tubes. The only difference is that here the frictional surface moves, while in the other the gas moves. The tar and liquor collect in the tank underneath and separate; the liquor flowing back to the pump to be recirculated, and the tar going to the deposit tank. The chloride of ammonia that is present in the gas is scrubbed-out along with the tar and dissolves in the liquor.

It will be evident that if the temperature of the gas and the ammoniacal liquor are just at the dew-point, neither deposition nor evaporation of liquor will take place. There is thus tar extraction without deposition of water. If the gas enters at a temperature above the dew-point, evaporation will take place, and so the liquor can be concentrated. In any case the gas will always leave the extraction plant at the dew-point. On the Continent tar instead of liquor is used in the extractor. The author has tried creosote, tar, liquor, and tar mixed, and liquor alone, and found liquor the most satisfactory. When tar alone is used any ammonium chloride present in the gas is not so effectively scrubbed out as when liquor is used. The important points noticed here are that the extraction of the tar is purely frictional, and that the temperature of the liquor is too high for the free ammonia to be dissolved. Apart from the special case of chloride, a little fixed ammonia may slowly accumulate in the liquor. This can be pumped into the saturator from time to time, and the bulk of the circulating liquor made

up with fresh water or by condensation from the crude gas. A view of the tar-spray pumps is given in fig. 5.

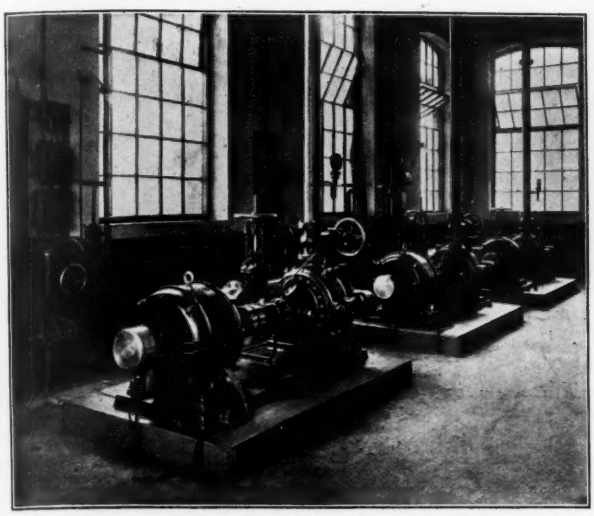


Fig. 5.—Tar Spray Pumps, Electrically Driven, for a 120-Oven Plant.

## Removal of Heavy Tar.

In gas practice various methods have been tried to remove the heavy tar from contact with the gas before complete cooling, with a view to preventing it absorbing light oil, and also with a view to reducing naphthalene trouble. So far as the author is aware, these attempts were without marked success. In the "Otto" method of tar extraction, there is a complete separation of the heavy tar from the gas while the temperature is still between 70° and 80° C. (158° and 176° Fahr.), and with practically no extraction of light oils, as the following distillation test of the tar here deposited shows:

| | | | | | | |
|---|---|---|---|---|---|---|
| Up to 170° C. | – | 7·25 | per cent. | (water = 5·25 | per cent.) |
| 170° C. to 230° C. | – | 6·50 | ,, | ,, | ,, | ,, |
| 230° C. to 270° C. | – | 13·50 | ,, | ,, | ,, | ,, |
| 270° C. to 290° C. | – | 19·75 | ,, | ,, | ,, | ,, |

The fraction up to 170° C. contained 5·25 per cent. of water, as the tar was not allowed to settle. The other 2 per cent. of this fraction consisted almost entirely of naphthalene. The fact that this tar does not contain the light oils permits of it being kept hot with steam, until complete separation from liquor takes place.

## Direct Ammonia Recovery.

The gas free from tar-fog, but still carrying the light oils, now enters the saturator (fig. 6). The distance from the tar-extractor to the saturator being only about 10 feet, any change in gas temperature is negligible. In passing through the saturator the gas is brought into intimate contact with the acid; being split-up into fine streams by passing through a slotted curtain which hangs into the acid liquor. The curtain is circular in plan, and the gas enters on the outside and leaves the saturator from the inside of the curtain. The depth of seal is adjustable. In the Auchengeich plant it is at present 14 inches. The acid liquor in the saturator is kept in continuous circulation by means of centrifugal pumps, or else by hot acid injectors. The salt is ejected by means of air and steam.

The net thermo-chemical change occurring in the saturator is exothermic, as may be seen from the following equations. Taking kilogram molecular quantities—

$$2NH_3 + H_2SO_4 = (NH_4)_2\,SO_4 + 65{\cdot}98 \text{ kilo calories}$$

$$2NH_4Cl + H_2SO_4 = (NH_4)_2\,SO_4 + 2HCl - 17{\cdot}82 \text{ kilo calories}$$

(Landolt and Börnstein Physical and Chemical Tables.)

$H_2SO_4$ (1·451 mols. water) to $H_2SO_4$ (19·05 mols. water) gives 8·65 kilo calories.

(Muir and Wilson's Thermal Chemistry.)

The proportion of ammonium chloride entering the saturator is very small, and is not all decomposed; so that it is practically only the cooling due to radiation and conduction which must be corrected. After each make-up with acid, the temperature of the acid bath rises several degrees; and this excess over the average temperature is some time in being dissipated by the passing gases, &c. Continuous salting would seem a natural development in direct recovery; and with a well-designed and properly-lagged saturator and continuous salting, the heat generated by the chemical actions would be nearly sufficient to account for all losses, and also evaporate the water added in the acid used. The ammonia passing the saturator and carried away in the gas amounts to about 1 oz. per ton of coal—better results are being obtained on more recent plants. [As is probably generally known, the Auchengeich plant was the first direct recovery plant erected in this country.] This small amount of ammonia passing being found sufficient to render the gas alkaline, no corrosion can take place from hydrochloric acid; and the amount of hydrochloric acid passing must be very small indeed. The tar-sprays in use at Auchengeich are the "Otto" old type, and are not so efficient as their latest type. A little chloride of ammonia gets into the saturator, but no corrosion has been observed, and none is feared. There is little doubt that, of the total chloride entering, only a small proportion is decomposed by the sulphuric acid.

The following analyses will give a good idea of the com-

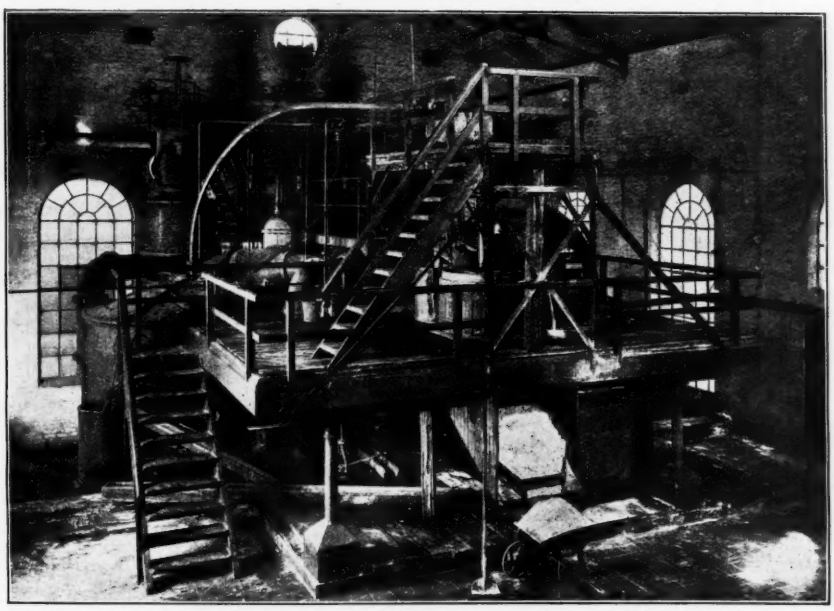


Fig. 6.—DIRECT SULPHATE PLANT.

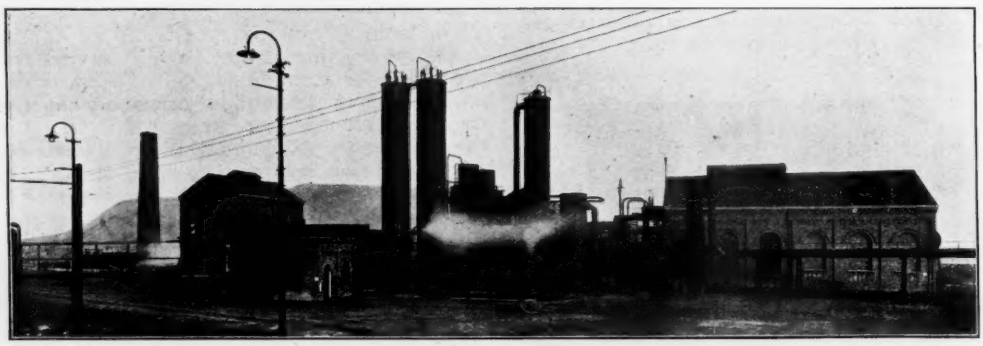


Fig. 7.—COMPLETE RECOVERY PLANT, INCLUDING ANNULAR AIR-COOLER, SPRAY PLANT, DIRECT SULPHATE PLANT AND STORE, NAPHTHALENE EXTRACTION PLANT, BENZOL PLANT, &c.

position of the acid liquor in its most acid state just after the make-up :

| Acid liquor 60° Twaddel at 84° C. | Per Cent. |
|---|---|
| Sulphuric acid (free) | 11·06 |
| Sulphate of ammonia | 43·70 |
| Hydrochloric acid (free) | ·01 |
| Chloride of ammonia | 3·38 |
| Water | 38·75 |
| Other solids | 2·85 |
| | 99·75 |

The unknown quantity of sulphuric acid present as acid sulphate and free acid, and the free and combined hydrochloric acid occurring together, make it impossible to determine all their respective quantities exactly. It will, therefore, be understood that some of the above sulphate will be present as acid sulphate, so lowering the amount of free sulphuric acid.

If the gas enters the tar-extracting sprays considerably above the dew-point, tar-fog will be produced in the sprays, so lowering their scrubbing efficiency. A little tar will thus get forward to the saturator. From the sample of sulphate specially prepared under such conditions, it will be seen how little this affects the colour even when the entering temperature is as high as 120° C.—that is, about 45° C. above the dew-point.

The passing of the gas through the acid bath is the only radically new feature in direct recovery. When the state of acidity of the saturator liquor is considered, there being considerably less than 11 per cent. of free sulphuric acid present, it is not to be expected that the illuminants benzene and ethylene would be attacked. Investigation has shown that this conclusion is correct. [See paper by M. Charles Berthelot, "Gas World," April 4, 1914.]

### Naphthalene Extractor.

From the saturator the gas passes to the naphthalene extraction plant (fig. 7). Here the gas first enters a vertical cooler, where it can be quickly cooled to about 55° to 60° C. The change in temperature and volume of the gas causes water, naphthalene, and some oils to be precipitated. The gas now saturated with these ingredients at this temperature, and carrying the precipitated portion as fog, passes into the extractor proper. Here it is further suddenly cooled to 18° to 22° C. by a cluster of high-pressure cold water jets, and simultaneously the fog is beaten out of the gas as in the tar sprays. After passing one more cold water jet, the cool gas goes to the exhauster. The cooling of the gas in the naphthalene extractor naturally acts also as an exhauster. The product here extracted flows into a small scum-pond, where it floats on the surface of the water, is skimmed off, and allowed to drain. The product is crude naphthalene crystals with a small proportion of oil. The exhauster (fig. 8) now forces the gas through the benzol scrubbers, or (if it be a gas-works) through the purifiers.

### Fractional Condensation of Tar.

When this process is reviewed, heavy pitchy tar is observed deposited in the mains and middle tar in the tar-extractors. These amount to about 2·75 per cent. on dry coal; naphthalene crystals in the naphthalene extractor about 0·13 per cent.; and crude light oil in the benzol scrubber about 1·2 to 1·5 per cent. There is thus a process of fractional condensation of tar products.

### Composition of Gas.

The following consecutive tests show the quality of the gas produced, the samples being taken at the saturator outlet. They also show the uniformity when eighteen ovens out of a thirty-oven battery are being charged per 24 hours, each charge being about 8½ tons.

All the analyses are corrected to the same amount of air present, based on 0·5 per cent. of oxygen.

| Time | 9.30 a.m. Per Cent. | 10.45 a.m. Per Cent. | 11.30 a.m. Per Cent. | 12.30 p.m. Per Cent. | 1.50 p.m. Per Cent. | 3 p.m. Per Cent. | Average. Per Cent. |
|---|---|---|---|---|---|---|---|
| $CO_2$ | 3·5 | 3·9 | 3·6 | 3·6 | 3·4 | 3 3 | 3·55 |
| $O_2$ | 0·5 | 0·5 | 0·5 | 0·5 | 0·5 | 0·5 | 0·50 |
| $C_nH_{2n}$ | 3·1 | 3 2 | 3·2 | 3·5 | 3·3 | 3 5 | 3·30 |
| CO | 8·1 | 8·0 | 8·0 | 8·0 | 8·1 | 8·1 | 8·05 |
| $H_2$ | 46·3 | 46·2 | 46 3 | 46·1 | 46·5 | 47·6 | 46·50 |
| $CH_4$ | 31·5 | 29·8 | 31·5 | 33·0 | 32·6 | 32·5 | 31·82 |
| $N_2$ | 7·0 | 8·4 | 6·9 | 5·3 | 5·6 | 4·5 | 6·28 |
| | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·00 |

Calorific value = 560 B.Th.U. net per cubic foot.

Some difference of opinion will exist as to the necessity of fractionally collecting the gas; but these analyses, and others of the poor gas quoted further on, furnish data on which opinion can be formed. The author is not able to give the actual yield of gas per ton, but considers it between 9000 and 10,000 cubic feet. At Middlesbrough, coke-oven gas from "Otto" ovens is to supplied for town lighting at 4d. per 1000 cubic feet, and this on a profit-making basis.

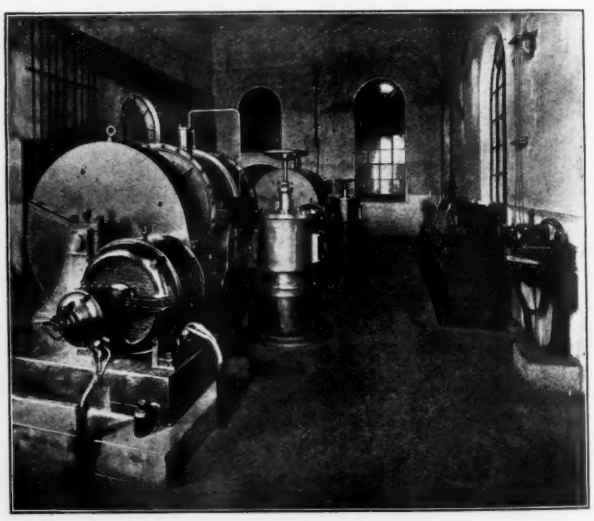


Fig. 8.—Low-Speed Exhausters, Electrically Driven, for the 55-Oven Plant.

### Yield of Ammonium Sulphate.

The yield of sulphate of ammonia per ton of dry coal on installations with which the author is acquainted varies from about 33 to 39 lbs. He has passed the higher figure over a considerable period, and has had an average over a year's working of about 36 lbs. The production of ammonium sulphate on a carbonizing plant is always an interesting question. In order to show how the ammonia in the gas varies from hour to hour of the carbonizing period, hourly tests of the gas were made, and the curve (fig. 9) obtained. The charge of dross weighed about 8½ tons; the wall temperature of the oven approximated to 1050° C. as

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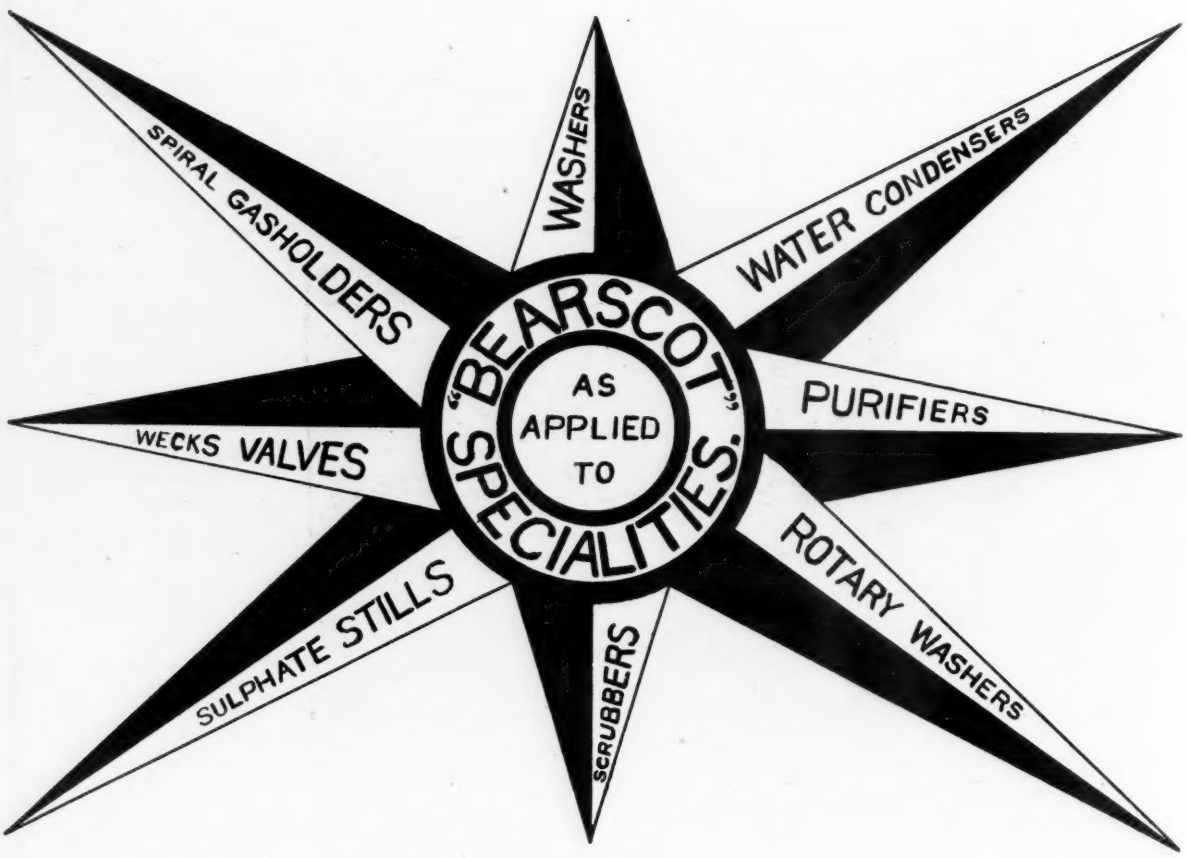



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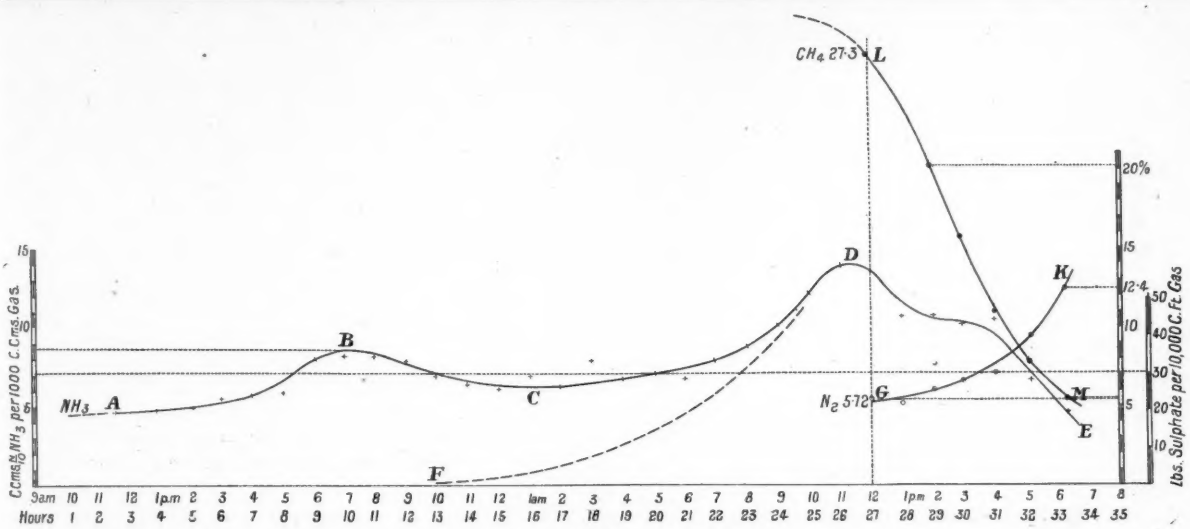



Fig. 9.—AMMONIA CURVES.

determined by a Féry radiation pyrometer; and the composition of the dross was as follows:

| | Per Cent. |
|---|---|
| Moisture | 11·70 |
| * Volatile combustible matter | 24·90 (silica crucible)† |
| * Non-volatile matter | 59·10 |
| Ash | 4·30 |
| | 100·00 |
| * Nitrogen | 1·64 |

† By platinum crucible (American method), 26·50 per cent.

By the tenth to the twelfth hour practically all the coal is dry, and the rate of evolution of the gas has increased, reaching the maximum between the tenth and the seventeenth hour. The hydrocarbons have risen to 7·5 per cent. and have fallen to 3 per cent. about the nineteenth hour. The ammonia concentration reaches a maximum at about the tenth hour—possibly due to the passage of steam through the hot coke just formed against the oven wall. This action now decreases, and there is a steady production of ammonia by straight carbonization. As the action of the steam ceases a new factor appears. The hydrogen evolved in the carbonizing, in passing through the red-hot coke, is liberating nitrogen and producing ammonia; and so the true maximum concentration is obtained at "D" about the twenty-sixth hour. Some such curve as F D can be imagined above which the ammonia produced in straight carbonization and by the action of steam is represented, and below which that produced in the secondary reaction by hydrogen is represented. This action of hydrogen in passing through red-hot coke was shown by Tervet during 1883 ["Journal of Society of Chemical Industry," Nov. 23, 1883, pp. 445, &c.]. After the twenty-sixth hour, the production of gas very rapidly falls and the temperature of the coke rises, and so the curve D E descends rapidly. From the analyses of the gas, it may be seen that the ammonia is either not being formed or is being decomposed. Curve G K shows how the percentage of nitrogen in the gas increased over this period; and curve L M (to the same scale) how the methane percentage rapidly falls. The complete analyses of the gas during these last six hours are as follows. [All the analyses were done with a "Bone and Wheeler Gas Analysis Apparatus."]

| Hour. . . | 28. | 29. | 30. | 31. | 32. | 33. |
|---|---|---|---|---|---|---|
| $CO_2$. . . | 0·64 | 0·00 | 0·98 | 0·64 | 0·62 | 0·36 |
| $O_2$ . . . | 0·00 | 0·00 | 0 00 | 0·00 | 0·00 | 0·00 |
| $C_nH_{2n}$, &c. | 0 90 | 0·88 | 0·88 | 0·72 | 0·60 | 0·59 |
| CO . . . | 8·45 | 10·62 | 6·72 | 7·88 | 7 82 | 7·48 |
| $H_2$ . . . | 57·50 | 62·30 | 69·40 | 72·80 | 73·60 | 73·67 |
| $CH_4$. . . | 27·30 | 20·25 | 15·74 | 10·96 | 7·82 | 5·50 |
| $N_2$ . . . | 5·21 | 5·95 | 6·28 | 7·00 | 9·54 | 12·40 |
| | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 |

The samples of gas were taken from the ascension-pipe about 4 feet above the crown of the oven. The ammonia absorptions were made in Dr. Gray's spiral absorber (fig. 10). In all intermittent carbonizing with deep masses of coke this Tervet action will occur. If the temperature of the coke, however, is too high, free nitrogen will result; and the curve above from C to E will flatten down, and may even be a steady fall. In continuous carbonizing, it may be noticed that the gas yielding partly carbonized coal tapers off towards the lower end of the retort, and, moreover, the carbonizing temperature gets lower. Little hydrogen being therefore evolved, the part played by this secondary action would not be prominent. In experimenting with the plant, the author has found it possible to produce satisfactory coke under such conditions as gave a variation in production of ammonium sulphate from 25 to 40 lbs. per dry ton. The range of temperature over which the maximum yield was obtained was small; but, as will be noticed, the flexibility of the process is very considerable.

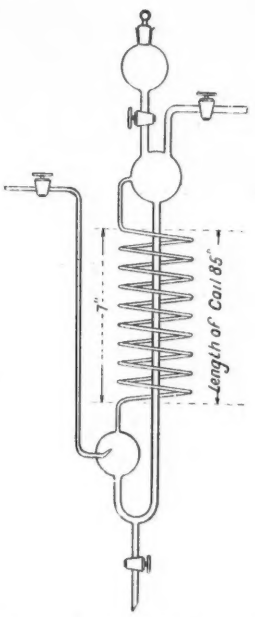



Fig. 10.—Gray's Spiral Absorber.

## Costs.

The capital cost of a sixty-oven installation of "Otto" regenerator coke-ovens with direct recovery as described above, and capable of carbonizing 360 tons of dry coal per 24 hours, would be about £60,000. This includes everything from the dross-tipping plant to the exhauster outlet, all bye-product plant in duplicate, but no power-generating plant. To this, for gas-works requirements, the author would recommend the addition of self-sealing doors, foul-gas governors, and an altered collecting main with a back liquor sealed curtain so as to facilitate pokering and cleaning without loss of any gas. On such a plant, with English conditions of wages, the wages cost from dross waggons to coke-bench would be about 10d. to 11·5d. per

ton of dry coal. The cost for coke filling, including upkeep, is:

By coke conveyor, 1d. to 1½d. per ton of coke.
By coke car, 1d. per ton of coke.
By Goodall loading and screening machine, 2d. per ton of coke.
By hand, 3½d. to 4½d. per ton of coke.

The total bye-product wages cost up to the outlet of the exhauster would be about 2d. to 3d. per ton of coal.

### Application of Ovens and Direct Recovery Plant.

The application of coke-ovens to gas making is naturally dependent on the supply of coking coal, suitable markets for products, and the size of the works. As the complete source of gas, the author would put the minimum size of installation at thirty ovens, carbonizing 180 tons of dry coal per 24 hours. In large works, where the gas might be mixed with horizontal or vertical retort gas, the installation might be as small as the capital and working costs would permit. When the number of small works selling gas at a relatively high figure is considered, and works (even fairly large ones) buying coal at a distance and selling some of their products in the same district as the coal supply, one cannot fail to be impressed by the economic possibilities of large central stations situated near the pit-head, with high-pressure distribution to even a considerable distance. If such installations were situated near the collieries, another possible economy appears. Many collieries have a considerable production of low-grade, at present unsaleable, coal. Such coal carbonized in retort producers of the Scotch shale type should yield a good financial return, in view of the maximum production of high-grade low-temperature oil, together with the large production of ammonia per ton of coal by the complete gasification; the surplus gas being available for retort or oven heating.

The question of direct recovery can be considered quite apart from the coke-ovens. As indicated, the one important factor is that the gas shall reach the tar-extraction plant not lower than the dew-point, and there can be no doubt that this would be easily done with modern vertical retorts. The whole bye-product plant on a direct-recovery installation takes up no more ground space than the exhauster-house, and water-tube condensers and scrubbers of a modern gas-works of the same carbonizing capacity.

From practical acquaintance with both gas-works and coke-works conditions, the author is of opinion that the whole "Otto" process can be suitably applied to town gas-making. He hopes he has succeeded in satisfactorily reviewing the "Otto" direct recovery process from the gas-maker's point of view.

### DISCUSSION.

The President: I do not propose to make any remarks on this paper, except to express our pleasure at seeing here a representative of a Junior Gas Association. I hope that it will be taken as a precedent, and that we shall have at future meetings many juniors present.

Mr. John Young (Hull): May I offer my congratulations to the author of the paper on having been selected as the first representative of the Junior Associations to read a paper at these meetings, and to express my feeling that the choice has been thoroughly justified? The subject which he has so ably treated is not a new one, so far as the Institution of Gas Engineers is concerned, because as far back as 1896 Mr. Charles Hunt read a paper on the Brymbo coke-ovens, with a view to discussing the possibility of using the gas produced from these coke-ovens either for the whole of the supply of town's gas or as an auxiliary. At that time I mentioned that I had visions of the period when the whole of our storage plant would be done away with—that the immense capital which we put down for storage plant would be eliminated—and that, given a coke-oven plant large enough to meet the maximum demand likely to occur, this minimum demand was always safe, and during the time that the whole of the coke-oven plant was being used the difference between the maximum and the minimum could be employed either for heating ovens or transferring power for other purposes. But this vision has been dispelled to a certain extent. As gas makers, we have to furnish gas whether our residual products are sold or not; and the *crux* of the whole question lies, in my opinion, in the principal residual which we make—coke. The author will forgive me if I say that he is suggesting the production of a coke the market for which is already very nearly overstocked. There are some gas-works in Belgium which, thinking that the iron trade would always remain in the glorious state it was in a year or two ago, have discarded the old method of making gas, and have erected coke-oven plant. They do not know what to do with their coke-ovens to-day. I need not point out to you that it is a coke which would not be used for domestic purposes; and the direction in which attention for the disposal of our principal product coke must be directed is that of domestic purposes. It may be very difficult for us to persuade the man with the shovel in the factory that coke is as good as coal. To begin with, the man who charges the coke with the shovel is the man who has to do the clinkering; and I must confess there is a little more ash in a ton of coke than there is in a ton of coal. Therefore, much as one would like to see the coking installation because of its economy of working as described in the paper, I fear that the main difficulty with us is the disposal of the principal product—coke.

Mr. J. P. Leather (Burnley): Mr. President and gentlemen, I do not wish to say very much on this point. I think we are all greatly indebted to Mr. Purves for bringing his paper forward. There is one point on which I think it will be handy as a matter of reference—and that is the description of the direct ammonia process. This is a point as to which we may very well consider whether it is possible for us to take the ammonia directly from the gas by means of acid, without, at the same time, destroying the gas as an illuminant, and for the other purposes for which we sell it. We must all be very thankful to Mr. Purves for giving us so clear a description of the process.

Mr. Purves: Mr. Young was wrong in suggesting that I advocated a universal application of coke-ovens, because, as I indicated in the last paragraph of my paper, there are several factors which would limit the possibility of their application—one of them being the availability of suitable markets for the products. While I did not advocate coke-ovens universally, I consider that the direct recovery is suitable for universal application, as direct recovery undoubtedly increases both the illuminating and the calorific values, because no light oils are extracted from the gas, for none of them appear in the tar. I tested the effect of scrubbing the gas with liquor, and found that the taking out of the carbonic acid and the sulphuretted hydrogen could only help the calorific value by about 4 B.Th.U. in a 560 B.Th.U. gas.

## LIME AND SULPHATE OF AMMONIA AS FERTILIZERS, AND HOW TO INCREASE THEIR SALE.

By JOHN WEST, M.Inst.C.E., M.I.Mech.E., &c.

(Honorary Member of the Institution.)

A review of the past is always interesting, more particularly so as indicating the great advance that has taken place through the aid of science in our industry during the period covering the greater part of the lifetime of the author, who, about sixty years ago, was articled to the gas engineering profession at a period when engineers encountered great difficulties in the disposal of the refuse lime, ammoniacal liquor, and tar.

It was the rule rather than the exception for large heaps of lime to accumulate, and great difficulties were encountered in its disposal. Then ammoniacal liquor had to be evaporated chiefly in the furnaces under the retorts, and by other means. To-day the manufacture of sulphate of ammonia is carried on in a large number of gas-works on a highly scientific basis, and has proved a valuable commercial commodity, not only to the public, as contributing to the reduced price of gas, but to the agriculturist in particular.

It has been the author's privilege to contribute in the past several papers at these gatherings; and the subject now dealt with may seem to many so widely different from those

his name has heretofore been associated with, that some evidence may be necessary with regard to his acquaintance with the agricultural question.

Briefly, then, at a very early age the author had opportunities of making a study of the ways and business methods of one of the largest and most advanced of agriculturists, nurserymen, and seedsmen in the Midlands controlled by his relations. He has never lost touch with this interesting business, and has watched its progress both in England and abroad.

On many visits to Denmark the methods there for many years past have been of great interest, and there is no doubt that the Danes have led the way and shown Great Britain what can be done by scientific farming, as they have, by their efforts and skill, more than doubled the production of the soil during the past 25 years, though the climatic conditions are not so good as those in England.

Valuable experience has also been gained in connection with an estate of 700 acres in Derbyshire, purchased mainly for the purpose of the minerals. The land comprised three dairy-farms, which, owing to the death of the tenants, shortly after acquisition, came under the direct supervision of the author. Bailiffs were appointed to control the farms; and 1000 tons of lime ash was at once purchased and spread over the meadows and pastures, with the result that much larger and better crops of hay than had heretofore been produced on this land were obtained.

In dealing with 50 acres, extra results were also produced in the growing of oats by spreading, with a special machine, 2 cwt. of ammonia mixed with fine earth and sand per acre. Sulphate of ammonia was also successfully applied in the cultivation of mangels and other crude crops.

Apart from a certain amount of pleasure in this new undertaking, the farms resulted in a commercial success. Difficulties with bailiffs, however, and the practical impossibility of giving the subject the necessary personal attention, interrupted this interesting study, although sufficient evidence was secured to indicate the commercial advantages of the use of artificial manures.

Fortunately another opportunity presented itself of acquiring information on this subject, as one of the author's sons, who originally started in another line of business, has taken to farming as a profession. Commencing with a small farm, he five years ago rented a larger farm in the neighbourhood of Burton-on-Trent. At the commencement the land was found to be in exceptionally bad condition, due to improper attention in the past. The produce from the land proved to be insufficient to provide for twenty cows and some young stock; and for the first two years it was necessary to purchase foodstuffs.

In the spring of the third year, it was decided to treat the land with artificial manure; and advice was obtained from the Principal of the Midland Agricultural College as to the best mixture for a wheat crop in a field already sown, and already showing indications of a poor crop. The following top dressing was used: 1 cwt. of sulphate of ammonia and 2 cwt. of superphosphates, at a cost per acre of £1 os. 7d. Within a week of this dressing being used a great improvement was evident, and the ultimate crop was exceedingly satisfactory. The straw was mostly 6 feet high, with long ears; and the total crop amounted to 55 bushels of wheat and 57 cwt. of straw per acre, both excellent quality.*

After this encouraging result, it was decided to treat the entire farm on scientific lines, and resort to artificial manures for the whole of the meadows, pastures, and other crops. Here it may be stated that in the years 1910-11 all the arable land and meadows were well limed.

At the beginning of the year 1912, a representative of the Sulphate of Ammonia Committee asked to be allowed to make some experiments in the centre of one of the meadows. This request was readily granted; and his report and the results of his experiments are appended.

*Plot No. I.*—This plot showed an abundance of coarse and long grasses; and had it been a dry season, no doubt the crop would have been very light. There seemed to be no sign of clover or trefoil. The bottom grasses did not show any indication of growth; but the coarse grasses might have smothered them. The weight, in my opinion, was greater in accordance than in plots Nos. 2 and 3.

*Plot No. II.*—This plot had a fair amount of clover and trefoil and also bottom grasses, and showed a distinct difference between plot No. 1 as regards not having such an amount of coarse grasses in it. It was not so high as plot No. 1; but the grasses seemed to be finer and thicker at the bottom than those in plot No. 1.

*Plot No. III.*—This plot was far and above the preceding two plots, and showed a greater abundance of clover and trefoil, and was very thick at the bottom of rib and other grasses. Its appearance was distinctive towards plots Nos. 1 and 2, and the mowing machine had great difficulty in cutting through the grass, being so thick; the bulk of it showed up very much as against plots Nos. 1 and 2.

In the author's opinion, this top dressing is most suitable for this strong land in Staffordshire. Attention may be called to the extra 11 cwt. 2 qrs. 7 lbs. of hay per acre from the addition of only 132 lbs. of sulphate of ammonia. It had been previously decided, however, to proceed with the use of artificial manures apart from the foregoing experiment; and on the recommendation of the Principal of the Midland Agricultural College all the meadows were treated with the following mixtures:

1 cwt. of sulphate of ammonia . . .
3 ,, superphosphate . . . . .
1 ,, sulphate of potash, and . .
15 loads of farmyard manure . . . .
} Cost per acre, £1 12s. 6d.

The total of the whole of the crops of hay on the meadows was excellent, and turned out, on the average, even better than the results from the experiments made by the Sulphate of Ammonia Committee.

It is interesting to point out that there was one meadow especially which was in a very poor condition, and prior to special treatment yielded very small crops. This was treated by a distribution of one ton of fine ground lime to the acre, and afterwards a top dressing of the foregoing mixture. This treatment produced such an enormous crop in the field that it was only with very great difficulty that it was mown; the mowing machine jamming continually. The crop was so heavy that it could not be handled by the modern machine for converting it into hay, and the old-fashioned hand system had to be resorted to.

Some able authorities have said that farmyard manure is

* The average wheat crop in Great Britain during this year was about 32 bushels per acre.

SULPHATE OF AMMONIA COMMITTEE.

MANURIAL EXPERIMENTS (SEASON 1912).

CROP—HAY.

Name and Address of Experimenter: ARTHUR H. WEST, Tutbury, Burton-on-Trent.
Name of Supervisor: T. BROWN, Hewetson.

| — | Plot No. 1. | Plot No. 2. | Plot No. 3. |
|---|---|---|---|
| Farmyard manure | ton per plot 10 tons per acre | ton per plot 10 tons per acre Autumn | ton per plot 10 tons per acre |
| ,, ,, When applied. | | | |
| Ground limestone | cwts. per plot | cwts. per plot | cwts. per plot |
| ,, lime | ,, ,, ,, | ,, ,, ,, | ,, ,, ,, |
| Chalk C M | 2 ,, ,, | 2 ,, ,, | 2 ,, ,, |
| | No artificial manure Sown Mar. 22, 1912 | 22 lb. superphosphate 30 p. ct. 11 lb. sulphate of potash 14 lb. common salt Sown May 7, 1912 | 22 lb. superphosphate 30 p. ct. 11 lb. sulphate of potash 14 lb. common salt 12 lb. sulphate of ammonia Sown May 7, 1912 |

Manure merchant

BRITISH FERTILIZERS, LIMITED, U.A. CO.

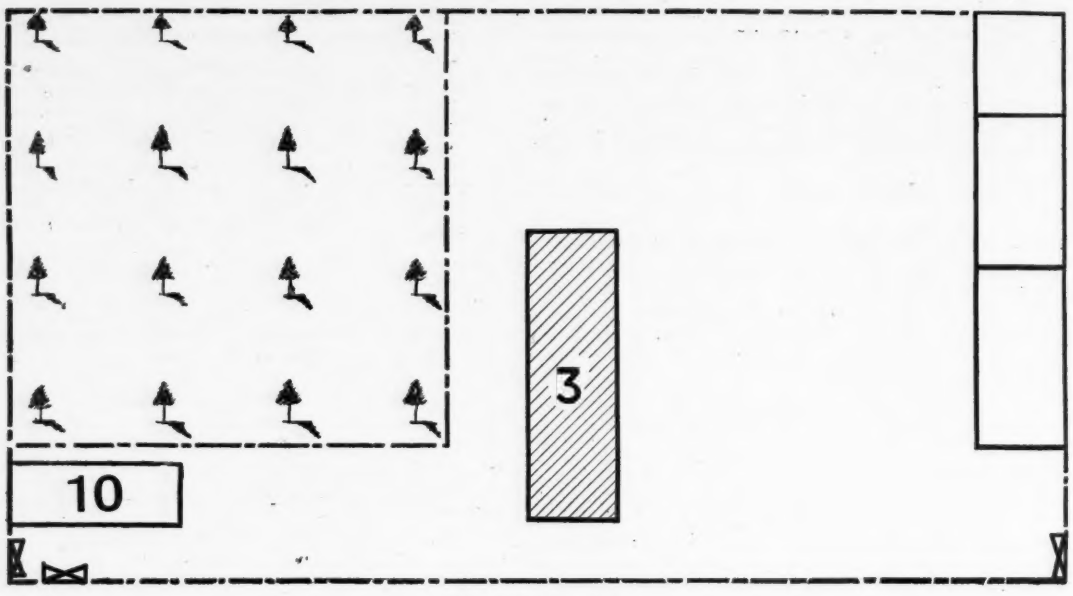
MANURES FOR PLOTS.

| For Plot No. 2. Number of Bags. Contents. | Per Plot No. 3. Number of Bags. Contents. | Per Acre. Lbs. |
|---|---|---|
| Bag No. 1 22 lb. superphosphate 30 per cent. | Bag No. 1 22 lb. superphosphate 30 per cent. | 242 |
| Bag No. 2 11 lb. sulphate of potash | Bag No. 2 11 lb. sulphate of potash | 132 |
| ,, ,, 3 14 ,, common salt | ,, ,, 3 14 ,, common salt | 154 |
| | ,, ,, 4 12 ,, sulphate of ammonia | 132 |

*Results of Experiments of Plots Nos.* 1, 2, *and* 3.

Mown Saturday, July 13, 1912. Hay weighed Thursday, July 18, 1912.

| Plot. | Total Weight in Lbs. of 111th Part of an Acre. | Total Weight of Grass per Acre. | | | | Total Weight of Hay per Acre. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Lbs. | Tons. | Cwt. | Qrs. | Lbs. | Tons. | Cwt. | Qrs. | Lbs. |
| No. I. | 210 | 4 | 19 | 1 | 20 | 1 | 9 | 3 | 8 |
| ,, II. | 846 | 7 | 2 | 3 | 7 | 2 | 2 | 3 | 5 |
| ,, III. | 978 | 9 | 1 | 0 | 20 | 2 | 14 | 1 | 12 |




**Stackyard, Year 1910.**

All Hay and Corn in Hay Barn. 10.—Mangold Wurzels.

not sufficient in itself to feed all the plants contained in the soil, and that some artificial manures are absolutely necessary as food for these plants. The field in question gave proof of this fact, as for the first time trefoil and clover predominated, where none of this had been seen previously; and 14 loads of hay instead of 4 was the result—chiefly derived from the use of sulphate of ammonia.

During the years 1913 and 1914 all the arable land, meadows, and pastures have been treated on scientific lines; and the plan shows the several stacks for the year 1913 as the result of the crops which were gathered into the stockyard in readiness for keeping the larger stock of cattle during the winter season. This stock has been nearly trebled since the farm was first taken. The wheat crop yielded last year over 7 quarters to the acre, with excellent straw weighing 56 cwt. to the acre. The wheat was of excellent quality, and was sold for 3s. per quarter above the current prices, for seeding purposes.

The oat crop was not so good this year, but much better than the crops in the immediate district; the yield being 5½ quarters per acre, with 43 cwt. of straw per acre. The hay barn and seed rick are estimated (as measured by an expert from the College) to contain 73 tons. This works out to 2 tons 9 cwt. per acre; being fully a ton per acre more than formerly obtained on the average on this farm.

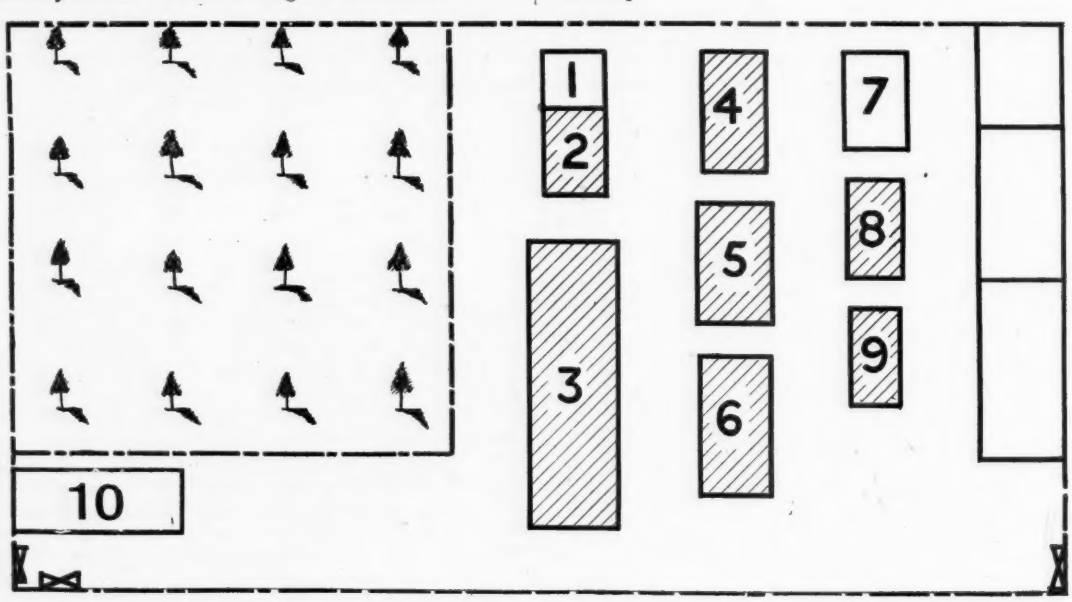
The meadows having been well treated with artificials the previous year, only a good dressing of farmyard manure was applied last year; but the seeds received a dressing of artificial manures as follows:—

| | | |
|---|---|---|
| ¾ cwt. of sulphate of ammonia . . . | } | Cost per acre, £1 2s. 6d. |
| 2 ,, superphosphate . . . . . | | |
| ½ ,, sulphate of potash . . . . | | |

### Mangold Wurzels.

Mangold wurzels are a very important crop on a dairy farm. Several experiments have therefore been made, both with farmyard manure and other fertilizers, with the object of ascertaining which kind of manure produces the best crops. The table, p. 957, shows the results in detail.

Referring to the table, it will be noticed that plot No. 7 shows by far the best results where artificial manures only are employed; the value of the same per acre being £35 18s. 9d., as against £21 5s. on plot No. 1 with farmyard manure only, at a higher cost per acre. Again, compare plot No. 2 with plot No. 7, where the seed was of the same kind. There was, however, the addition in plot No. 7 of 1 cwt. more sulphate of ammonia, costing 14s., which has produced 7½ tons more wurzels. These are worth, after deducting 14s. for the sulphate of ammonia, £4 over plot No. 2 crop. Hence the value of sulphate of ammonia for this crop.




**Stackyard, Year 1913.**

1.—Straw (previous year). 2.—Oats. 3.—Hay Barn Full. 4.—Wheat. 5.—Wheat. 6.—Seeds.
7.—Oats and Clover (previous year). 8.—Oats, Clover, and Rye. 9.—Oats. 10.—Mangold Wurzels.

MANGOLD WURZELS.

| No. of Plot. | Kind of Seed Sown. | Analysis of Manures. | Quantity per Acre. | Cost per Acre. | Tonnage per Acre. | Value per Ton. | Value of Mangolds per Acre. | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Tankard mangold . . | Farmyard manure only | 30 tons at 4s. per ton. | £6 | 34 | 12s. 6d. | £21 | 5 | .. |
| | | Farmyard and Artificial Manure Combined. | Detailed Cost. | | | | | | |
| 2 | Sutton's prizewinner, yellow globe . . | Farmyard Manure, 20 tons at 4s. per ton. / Artificial Manure. Superphosphate. 4 cwt. / Sulphate of ammonia. 1 cwt. / Sulphate of potash. 1 cwt. | Farmyard manure, £4 Artificial manure, £1 17s. 9½d. | Total cost, £5 17s. 9½d. | 50 | 12s. 6d. | £31 | 5 | .. |
| 3 | Green's yellow globe mangold . . . . | Do. / Do. / Do. / Do. | Do. | £5 17s. 9½d. | 50¼ | 12s. 6d. | £31 | 8 | 1½ |
| 4 | Midland Farmers' Co-operation yellow globe . . . . . | Artificial Manure only. 5 cwt. per acre Hatfield's Special Mangold Manure. | | £1 17s. 6d. | 44 | 12s. 6d. | £27 | 10 | .. |
| 5 | Sutton's prizewinner yellow globe . . . | 10 cwt. per acre Hatfield's Special Mangold Manure. | | £3 15s. 0d. | 49 | 12s. 6d. | £30 | 12 | 6 |
| 6 | Tankard mangold . . | Superphosphate, 4 cwt. / Sulphate of ammonia, 1 cwt. / Sulphate of potash, 1 cwt. | | £1 17s. 6d. | 40 | 12s. 6d. | £25 | .. | .. |
| 7 | Sutton's prizewinner yellow globe . . . | West's Mixture / Do. 4 cwt. / Do. 2 cwt. / Do. 1 cwt. | | £2 13s. 2d. | 57½ | 12s. 6d. | £35 | 18 | 9 |

Common salts at the rate of 4 cwt. per acre were drilled into land before the ground was drawn up into ridges ready for sowing seed for mangolds

NOTE.—The average yield of mangolds per acre throughout the United Kingdom was about 20 tons last year.

It was noted that the wurzels grown with farmyard manure only were very irregular in size, and had a superabundance of top leaves; whereas those grown from artificial manure were very even and regular in size, with very little top, had sound roots, and have kept well during the winter.

The Midland Agricultural College has for the past four years been experimenting on manuring pastures for producing milk. In this they have been very successful, and have proved that it is a profitable investment. The manures they applied per acre were as follows:

10 cwt. of lime.
4 ,, superphosphate.
1½ ,, sulphate of potash.

It was decided to treat the pasture land, consisting of 64 acres, on somewhat similar lines. These pasture fields have all been prepared first by distributing one ton of fine lime per acre over them with a very good mechanical distributor, and to this has been added a mixture as follows:

½ cwt. sulphate of ammonia per acre
1½ ,, ,, potash ,, ,,
3½ ,, superphosphate ,, ,,
1 ,, common salt
} Cost per acre, £1 9s. 6d.

This mixture, as far as can be ascertained, is producing excellent results. The farm in question consists of 115 acres, and is equipped with a very good farmstead; the latter being considered to be too large for the acreage, as some years ago a portion of land was taken off. At present the stock of milking cows is double that existing formerly; and a farmstead which was once considered too large for the land has now, through scientific methods, become too small, and is at present being extended.

## LIME.

Lime is a most essential element in all agricultural work; and it is well known that without sufficient lime in the soil the chemical fertilizers—which are the mainstay of profitable cultivation—cannot exert their full benefit.

1.—It promotes the decomposition of humus or organic matter in the soil, rendering it available as plant food.

2.—It corrects sourness and improves the quality of herbage.

3.—It hastens the process of nitrification and improves the physical character of the soil and promotes healthy growth, &c.

All lime should be ground fine, and applied to the land by a suitable manure-distributing machine. When fertilizers are regularly used, it is necessary and economical to apply about 10 cwt. of lime per acre per annum, or one ton per two seasons. Good gas lime is excellent for this purpose; but it requires to be ground in a mortar-mill before leaving the gas-works, as it is essential for proper distribution on the land that it should be in a fine state of division. Where lime is used for purification, it should secure a ready sale at a good price per ton if supplied to farmers in a proper condition; and its usefulness as a fertilizer can no doubt be extended by suitable advertisements.

## SULPHATE OF AMMONIA.

For many years a very high opinion of sulphate of ammonia as a fertilizer has prevailed; but not until recent years has its complete advantage and great value to agriculturists been fully appreciated. The conclusive results obtained and set forth in this paper have considerably enhanced the opinion of the writer as to its value; and when the results of its application are properly valued by farmers, it will undoubtedly prove to be the most economical manure on the market.

It should, however, be pointed out that it is difficult to deal with and distribute on the land, especially when used without another artificial manure. It has first to be prepared by mixing it with dried earth or sand and passed through some very fine screens before it is possible to distribute 2 cwt. over one acre of land equally by a distributor. There are many farmers who are not aware of its full value, and, moreover, will not go to the necessary trouble of properly preparing the manure so that it can be distributed over a large area in a subdivided state to make it fully and completely efficacious on the land.

In the writer's opinion, sulphate of ammonia in many cases is not being sold as a suitable commercial article ready for immediate use by the agriculturist. It would beyond doubt pay well to prepare this valuable manure ready for use by thoroughly mixing it with earth or fine sand and selling it at so much less per ton, with a guarantee that it contains a certain fixed percentage of nitrogen. It is also worthy of consideration as to whether the hiring-out of distributors to farmers should not be made a commercial success, as there are very few who possess this valuable and necessary machine.

The gas industry has for many years past, and more particularly the last few years, through the agency of the British Commercial Gas Association, demonstrated that publicity and wise advertising lead to increased sales of gas; and somewhat similar methods could be advantageously applied in connection with the use of artificial manure among the farmers of the respective districts. It is certainly not to the credit of the British farmer that he should lag so far behind other countries in the development of his business. Undoubtedly the old-fashioned farmer to-day is somewhat prejudiced against the use of artificial manure. It is therefore upon the younger generation that we must depend, as they have received better education and have attended agricultural lectures.

Summing up the whole matter, it is doubtful whether the old system of farming, taking into consideration the higher rates of wages and the extra cost of living, together with

the high prices of food-stuffs, is at present a very profitable business. On the other hand, by the use of science, in the direction of artificial manures, farming can be made a very profitable business. This has been successfully proved by the figures put forward.

As a nation we have provided colleges and professors to educate these men; but it is regrettable that the major portion of them have not taken advantage of the enormous privileges which have been offered at so great a cost to the general community. This seems to indicate that farmers are rather a slow race of men, and are satisfied to go on in the slow, humdrum way of their forefathers; but the higher wages required by the labourers, and the extra cost of living, will not permit them to go on much longer on the old lines, so they will be forced to seek a remedy.

At the present time about 380,000 tons of sulphate of ammonia are produced in Great Britain, and only 101,000 tons are consumed by the farmers in the country; whereas in Germany they used 425,000 tons last year. This is because the German farmers are better educated in this direction. They obtain the best expert advice, and use sulphate of ammonia in larger quantities, because they have proved that they get the best returns from it.

On the Bushton Farm, Tutbury, Burton-on-Trent, containing 115 acres, there has been distributed on the land during five years 369 tons of lime and 51 tons of artificial manure more than heretofore, and, with the larger stock, about double the quantity of farmyard manure. The necessary labour employed by this scientific farming is increased about 25 per cent. Therefore, by these means labour is being brought back to the land, which must be a great advantage to the country generally.

There is about 6 million acres of grass land in Great Britain; yet we have to import large quantities of hay into the country. There are also some 40 million acres of land employed for various purposes which could be very profitably treated with artificial manures, and which, if properly dealt with, could grow all the hay the country requires.

About ½ cwt. of sulphate of ammonia per acre has been used on the average at Bushton Farm during the last three years; and if this small quantity were applied on the available land in Great Britain, ten times more ammonia would be employed than is the case at the present time. So that there is before the gas industry a very large business, which it is advisable (and in the interests of all concerned) to endeavour to capture—in fact, the writer is looking forward to the time when gas-works will not be able to produce sufficient for the English agriculturist, as, when once he has tested and proved the advantages of the use of sulphate of ammonia, he will crave for more.

The time has come when the farmer should dwell on the words of His Majesty the King when he suggested, after his return from abroad, that England should "wake up." The majority of the farmers might well carry out the King's excellent advice; and the writer would also say to those farmers who have not commenced scientific farming to begin at once, so as to quickly benefit themselves and do good to the gas industry and Great Britain generally.

In conclusion the writer trusts that he has demonstrated clearly that the agricultural and gas industries are closely allied.

Probably the last experiment with the pastures is of the greatest importance. We have clearly proved that sufficient hay can be obtained from the meadows, also plenty of corn, roots, &c., from the arable land to feed about 75 head of stock during the winter season; but if the pastures could not be improved over former years, some of the stock would have to be sold. This would have materially affected the profits. Since the paper was written, about a month ago, the cows and other stock have been feeding on these pastures; and I visited the farm last Friday, to see the effect produced after this month's grazing. I am very glad to say that I found an excellent crop of grass on all the pasture fields. Formerly, you saw small patches of clover here and there; but now we find it almost universal over all the fields. I found the growth of the grass was faster than it was consumed. Therefore it is anticipated that there will, with fine weather, be a good supply for all the stock during the summer months. The cows and all the stock are looking better than in former years. There is a considerable average increase in the yield of milk per cow—up to the present fully 15 per cent.; and it is daily increasing. I sent a sample of this milk to be tested.

I have been asked to give some information as to the use of artificial manures for use in gardens, greenhouses, and orchards. I may say that two years ago I adopted the Excellent Standard Dressing, as recommended by the Sulphate of Ammonia Committee, and which I have proved to be a very valuable mixture for obtaining good results. It is as follows:

| | |
|---|---|
| 56 | lbs. of superphosphate. |
| 28 | ,, ,, sulphate of ammonia. |
| 14 | ,, ,, sulphate of potash. |
| 14 | ,, ,, standard bone flour. |
| 112 | |

This should be well mixed together in a heap, passed through a screen with ⅛ mesh, and kept in a dry place.

Then, assuming that your garden has been well manured, I should give it a top dressing of fine ground lime of from 4 to 6 oz. per square yard, and afterwards a dressing of from 4 to 6 oz. of the standard dressing. I advise that you obtain a small pamphlet published by the Sulphate of Ammonia Committee, which will give you all the valuable information you require. I also advise that gas engineers freely distribute this pamphlet.

At this point, I should like to say that no one more appreciates what the Sulphate of Ammonia Committee have done, and are doing; but the question arises, Are they going far enough and fast enough, and should not more money be spent in connection with this matter, so as to get into direct contact with the farmer, and persuade him to purchase this valuable manure? My sons and I, about a fortnight ago, discussed this matter with the chairman of a very large undertaking; and he is very strongly of opinion that some forward action should be taken in connection with the sale of sulphate. Yesterday another chairman and secretary were of the same opinion, and suggested that the matter should be dealt with by your Local Committees, and asked me to think the matter over. I believe this a very good suggestion. You could appoint an agent, or agents, and pool the profits. I congratulate you on the success of your Commercial Committee; you have proved equal to the occasion.

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The PRESIDENT: Mr. West has demonstrated this matter in a most satisfactory manner; and my only regret is that there is no time to ask anybody to take part in a discussion on the paper this morning. Mr. West, I understand, will be glad to receive any communication or questions you may put to him; and we will publish whatever may be sent forward in that way in the report of the meeting. We are very much indebted to Mr. West. He, in respect of this, as in other matters, shows a display of energy which we younger men may very well envy.

## LARGE SET OF HUMPHREY GAS-PUMPS.

An installation of Humphrey pumps has been ordered by the Ministry of Public Works of the Egyptian Government for the drainage of Lake Mareotis at Mex, near Alexandria. When completed, this plant will be one of the largest pumping installations in the world, and will consist of eighteen pumps, each capable of delivering 100 million gallons of water per day through a lift of 20 feet. The present order includes the first ten of these pumps, together with the necessary gas-producer plant, Venturi water-meters, and a complete gas-driven electric light and power installation. Each pump unit will be capable of delivering between two and three times the quantity of water discharged by each large unit installed at the Metropolitan Water Board's pumping-station at Chingford, particulars of which have already appeared in the "JOURNAL." The maximum internal diameter of the combustion chamber will be 8 ft. 8 in., and its height about 14 feet. The water-valve box will be of like diameter and 7 feet high, and will be fitted with 100 valves of the hinge type, specially designed to enable any valve to close upon an obstruction without throwing undue strain upon the hinges. The anthracite gas plant will consist of nine producers (one being kept as a stand-by), and will be equal to gasifying 44 tons per day. The plant for furnishing power and light will comprise two gas-engines of the two-cylinder horizontal type, each for 180 B.H.P. normal load, running at 190 revolutions per minute, and direct-coupled to 120-kilowatt generators. There will be two Venturi meters, each arranged to measure the water delivered from one or more pumps up to a total of five. They will be of square section, and measure 12 in. by 12 in. in the throat. They are guaranteed to be accurate within 1·25 per cent. The whole of the work, which includes other plant not mentioned here, will be carried out under the supervision of Messrs. Harper Bros. and Co., the Consulting Engineers to the Egyptian Government.

## NOTICE TO GAS COMPANIES & CORPORATIONS, METER MANUFACTURERS.

It has come to my notice that a very inferior imitation of the M. & M. Patent Meter Lock is being made and sold as the genuine M. & M. Patent. **This is an Infringement of my Patent Rights**, and Gas Companies and Corporations would greatly oblige by informing me if they are not obtaining the genuine Lock.

The M. & M. Patent Meter Lock—of which over **735,000** are now in use—still retains its reputation for reliability, strength, and cheapness.

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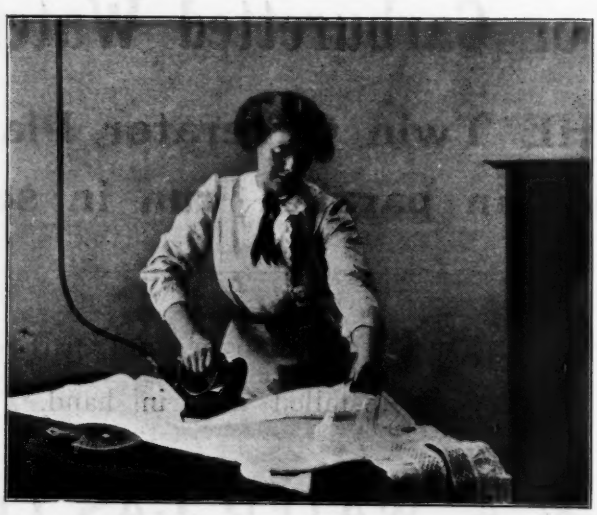

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## PERSONAL.

Last Saturday, Mr. FRANK WEST, the fourth son of Mr. John West, J.P., of Southport, was married at St. Paul's Church, Wimbledon Park, to Miss Muriel Dorothea Fountain, daughter of Mr. J. S. Fountain, of Boscastle, North Cornwall.

Mr. M. H. LAVELLE, of Fermoy, has been appointed Manager of the Tramore (co. Waterford) Gas-Works, by the Public Health Committee, subject to the approval of the Council, in succession to Mr. Kirkham, who, as already recorded, has taken over the managership of the Enniscorthy Gas-Works.

Mr. WILLIAM ERNEST DEAN, Assistant Engineer and Manager of the Torquay Gas Company, has been appointed Secretary and Manager of the Exmouth Gas Company, in succession to Mr. J. T. Foster, who has resigned. There were 97 applicants for the post, which was advertised in the "JOURNAL" for May 19. Mr. Dean is 34 years of age and married; and he has the highest credentials. For "Gas Engineering" and "Gas Supply" he has taken first-class certificates (honours); has had a two years' course in electrical engineering at the London Polytechnic; has studied mechanical engineering, building construction, structural and reinforced concrete engineering; and has been lecturer at the gas classes held under the Torquay Education Committee. From 1894 to 1906 he was training in the works of the Tottenham District Light, Heat, and Power Company. He has been with the Torquay Gas Company from 1906 to the present time, and has had entire control of men, works, and plant in all departments. He has also had considerable experience of secretarial duties.

## OBITUARY.

The death is announced of Mr. THOMAS HASSETT, the Secretary of the Clonmel and Cahir Gas Companies. Deceased had reached his seventy-second year.

The Council of the Yorkshire Junior Gas Association announce with regret the loss by death of their Hon. Treasurer, Mr. CHARLES H. TURNER, who was with the Mirfield Gas Company.

The death occurred on the 11th inst., at the early age of forty-four, of Mr. GEORGE LENNON, the Lessee, Manager, and Secretary at the Dungarvan Gas-Works. Deceased had been for some time in bad health; but his death came rather unexpectedly. He was elected a member of the North of Ireland (now the Irish) Association of Gas Managers in 1897, but his membership ceased a few years ago. He was highly esteemed by his colleagues, by whom he will be greatly missed. He leaves a widow and family.

## RETIREMENT OF MR. THOMAS BOWER

### And Appointment of his Successor.

THE name of Mr. Thomas Bower has been so long associated with the Hartlepool Gas and Water Company that it will seem strange to see its displacement from the position that it has so long occupied over the official title of "Engineer and Manager." It is only in the nature of things that official ties should some day be severed; but they would not, in this instance, have been severed yet, had it not been for the state of health of our long-time and highly respected friend. On his own initiative, relief from duties is being brought about, as he felt that, owing to the fact that health compels fifteen weeks out of the fifty-two being given up to special treatment, he could not during those weeks be devoting himself as conscientiously as he has hitherto done to the Company's interests. The Directors of the Company, with the deepest regret, accepted the proposal; but only to the extent of the cessation of active official service, for they have asked Mr. Bower to continue with them as consultant, and to attend Board meetings, and assist them with such advice as he can give them. With that implicit reliance, too, upon his good judgment which has been established and hardened with service, the Directors asked him to take in hand the appointment of another man as Engineer and General Manager. There was one who is eminently fitted to succeed Mr. Bower, in view of his training and knowledge of the Company's business—that is Mr. Arnold Wiseman Branson, of the Rhymney and Aber Valleys Gas and Water Company—Mr. Bower's first pupil, and subsequent assistant for six years. Mr. Branson has accepted the invitation to take the office; and he begins his new duties as from next October. By these changes Mr. Bower hopes, and all his friends in the industry trust, that he will be able to husband his health.

It is now thirty years since Mr. Bower went to Hartlepool. Eight years prior to that he was at Lytham; and his engineering training was obtained at Low Moor—one of the great seats of the iron industry. Gentlest of natures, amid iron Mr. Bower was born—for Low Moor claims him as one of its sons, his family predecessors having been long connected with the famous Low Moor undertaking for more than one hundred years. In fact, Mr. Bower was the first of the family tree, during upwards of a century, to leave the district and the Low Moor works to occupy a sphere elsewhere. It has been a strenuous time at Hartlepool. In one year, Mr. Bower had as much as 26 per cent. increase in the gas consumption with which to deal. When he joined the Company, the output of gas was only 130 million cubic feet; it is now about 500 millions—and this despite the fierce competition of electricity under the management of the Corporation. Electricity is used for public lighting, and current is sold at as low a price as ¼d. per unit for some purposes. Notwithstanding this, the Company have been able to hold their ground; and this is an illustration of how largely it is necessary for the chief executive official of a gas undertaking to be commercially brilliant as well as so in construction and manufacture. During the long tenure of office by Mr. Bower, he has practically rebuilt the Company's works, and has prepared designs for an entire new 6 million per day plant on 15 acres of ground. The completion of this scheme, however, has been largely held in abeyance, except that the first section of purifying plant (1½ millions) has been put down, a ¾ million a day carburetted water-gas plant erected, as well as a 1½ million gasholder. At the time Mr. Bower was appointed, the price of gas was 2s. 10d. per 1000 cubic feet to ordinary consumers, which was not by any means bad for those days; now it is 2s. 2d., with 2d. discount for prompt payment—making the price 2s. net. For power purposes the price is as low as 1s. 6d. The water part of the business has also been increased—in fact, at a rate greater even than that of the gas supply.

Outside the Company, Mr. Bower has given help to surrounding gas and water concerns, both in the matter of the designing and construction of works, as well as in parliamentary matters. The whole of the time he has been at Hartlepool, he has been closely connected with the North of England Association, and has passed through the Presidential Chair. Particularly by the younger members of the profession in the Northern district, he is looked upon affectionately, and as almost a sort of professional "father." Into his retirement from official work, he will carry the esteem and respect of a large number of friends—not only in the North, but in all other quarters of the country. To his successor, Mr. Branson, we express the hope that there may be in store for him a career as good, useful, and successful as the one that includes his own introduction into, and training in, the technical and commercial work of gas and water enterprise.

## DEATH OF MR. THOMAS THORP.

WE regret to record that Mr. Thomas Thorp, F.R.A.S., of Whitefield, near Manchester, died last Saturday week, the 13th inst., at "Uplands," Prestatyn, North Wales, in his sixty-fourth year. He had been engaged in scientific research for almost a lifetime; and his inventions, some of which had far-reaching effects upon the scientific as well as the commercial world, were numerous, particularly those relating to the use of gas.

Mr. Thorp was the son of a farmer at Besses-o'-th'-Barn, Lancashire. He was educated at the Manchester Grammar School, and was subsequently apprenticed to Messrs. Maycock and Bell, architects and surveyors, of Manchester. While with them he did a great deal of pioneer work in connection with the town-planning of New Brighton. Besides buildings of a domestic character, he designed the Prestwich, Whitefield, and Little Hulton Liberal Clubs, Stand Lane New Jerusalem Church and Schools, Besses New Jerusalem Church and Schools, and various manufacturing works in Lancashire. He was Consulting Engineer to the Whitefield Local Board and later to the District Council for close upon thirty years, and in this capacity laid out the park at Whitefield.

At an early age, Mr. Thorp was seriously engaged in scientific research, and was one of the first, if not actually the first, to produce a penny-in-the-slot gas-meter. In conjunction with Mr. Marsh, he took out a patent for one in 1889; and this was followed by others for improvements. The original meters of this kind put on the market were made at Mr. Thorp's works at Besses-o'-th'-Barn, and used in Casino Street, Liverpool; and some of them are still to be seen there. He was also the inventor of the rotary meter for the measuring of gas; and he produced the discount meter—a rotary meter on a small scale—which has proved useful, and is now generally employed. He was the patentee of a large number of inventions relating, among other things, to gas-lamps, gas and vapour burners, anti-pulsators, time-recorders for gas-lamps, pressure-recorders, &c. At the time of his death he was engaged in perfecting a cinematograph screen. The premises at Besses-o'-th-Barn were largely used for the production of his inventions in their initial stages, and when they reached perfection they were usually transferred to the control of companies formed to give them a commercial value. Forty workmen were employed, most of whom had been with him from youth. In a quarter-of-a-century the passing away of Mr. Thorp, the employer, represents the first death among the small band who have taken part in the production of the numerous inventions which have emanated from the works.

Mr. Thorp's knowledge was, however, not solely confined to the scientific world, for there were few aspects of art and literature with which he was not conversant. He was a Fellow of the Royal Astronomical Society; a member of the British Association, and had served on its Committees; a Vice-President of the North-Western Branch of the Astronomical Society; a member of the Council of the Manchester Literary and Philosophical Society, which is recognized as the most important of its kind outside London, and of which he was asked to succeed Professor Harold

B. Dixon, F.R.S., as President, but declined. A kindly, unostentatious, and retiring man of simple tastes, he refused to enter political life to any extent; being always happy, optimistic, and buoyant in pursuing, in the background as it were, his scientific researches. At "Uplands" he built an observatory on the hill overlooking the sea, for the purpose of furthering his astronomical researches. It was here that were manufactured lenses for the most powerful telescopes in the world. Mr. Thorp leaves a widow and three sons—Frank, Clifford, and Harvey.

The funeral took place at All Saints' Church, Stand, in the presence of a large number of people. The bearers were the six oldest employees in the Besses workshop; the procession being headed by representatives of the various Societies Mr. Thorp had been connected with. A special memorial service was held on Sunday; Science, Art, and Philosophy being strongly represented.

### AN APPRECIATION BY MR. THOMAS G. MARSH.

Some forty years ago, Mr. Thorp was one of a coterie of youths who gave their leisure to the consideration of scientific and engineering subjects—not as a matter of business or profit, but from a desire to acquire knowledge, and to satisfy themselves as far as possible on matters not generally understood. It was at one of their meetings that I first made his acquaintance—an acquaintance that ripened into a deep brotherhood which has existed up to the end of his life, and a confidence between ourselves so great that during the whole of our business connection each relied upon the other, and felt that there was no necessity for legality or agreements other than the confidence and friendship that existed between us.

Our first memorable adventure in gas matters was the introduction or the "aerorheometer." This instrument showed at a glance the quantity of gas passing through it. Very many thousands of these were supplied, and the instrument was never patented—the secret of manufacture being held inviolable. All attempts by others to manufacture the instruments proved this to be so, as the results were unsatisfactory.

In the days of regenerative lighting, the ability and patience of Mr. Thorp were taxed nearly beyond endurance. Almost night and day for months together he worked upon the lamp with which his name was associated. This lamp was awarded a gold medal in acknowledgment of its giving the greatest illuminating power per cubic foot of gas that had been achieved up to that date. In the competition there were other memorable inventors, most of whom had gone before him. Of these I may mention Siemens, Sugg, and Bray.

The gas industry owes to Mr. Thorp a tribute of acknowledgment for his connection with the slot gas-meter. It was under licence, upon the patents of Thorp and Marsh, and of Marsh, Thorp, and Haines, that the meters were manufactured, in the first instance, for Liverpool—this city being the first to have a large installation.

The other inventions with which Mr. Thorp's name was connected with the gas industry may be counted by the score. Though he did so well in these practical matters, his desire was always to be considered rather as a scientific man than as a practical engineer or business man. His holidays and spare time throughout life were devoted to scientific study, as this appeared to him the greatest pleasure and relaxation. He never felt ambition for place or power in local or other bodies. Though frequently asked to undertake such positions of trust, his invariable answer was that his life would be much more valuable if given to the study of science. His friendships among men of science were many, and his correspondence with them was extensive and world-wide.

He was the original inventor of the transparent diffraction grating. This was never patented by him, but given generously to the world; his aim being to place a diffraction grating on the market at such a price as would bring it within the reach of colleges and technical schools. Many of these places owe their possession of these gratings to Mr. Thorp's generosity, as he supplied them at a nominal price. The gratings were perfectly marked with 14,500 lines to the inch.

Mr. Thorp was a Fellow of the Royal Astronomical Society, and a Vice-President of their North-Western Section. He frequently wrote papers and appeared before scientific societies lecturing on astronomy. He accompanied the Solar Eclipse Expeditions to Algiers and Burgos; important results being obtained by his special instruments. He was a member and regular attender at the meetings of the Manchester Literary and Philosophical Society. During his life he received many awards for, and testimonials to, his abilities. At the Franco-British and St. Louis Exhibitions he was awarded a gold medal for his scientific displays; but well I remember his pleasure and his pride when he was awarded the Wilde Premium for original scientific work. Personally Mr. Thorp was the most unassuming of men, with a generosity and kindness of heart that made for him a host of friends. He was willing at any time to place his abilities at the disposal of his friends; and many are the experiments he made, and useful is the work he did, for inventors and scientific men whom he met during his life journey. This was done free of all charge, and often at great inconvenience and expense to himself—expense in both time and money; the former being what he prized more than anything. To these men he was always easy of approach—his desire being to add to the list of scientific men; and he will be greatly missed among them.

Looking over the long years of friendship, the sad memories are touched with sunshine when I reflect on the many happy hours we spent together, and the lasting affection of a lifetime, and remember that his life now closed was well spent, and in full accord with a quotation frequently made by him: "The world is my country; mankind my brethren; to do good my religion."

## GAS-COAL CONTRACT RENEWALS.

As everyone connected with the commercial side of gas concerns is aware, contracts for coal with inland works are arranged each year from July 1. Negotiations are usually commenced about the middle of May, and generally by this period most of the business has already been fixed up. So far, however, only a comparatively small tonnage has been arranged. It will be remembered that when the time for contract renewals came, after the six weeks of the national strike of colliers, early in 1912, collieries had little difficulty in securing advances of from 2s. to 2s. 6d. per ton, while last year the further advances obtained brought prices 3s. 6d. per ton higher than on the 1911-12 contracts.

With the very obvious decline in trade, gas engineers have naturally been expecting to buy their raw material at lower rates. The heavy fall in the prices of residuals—especially gas-coke and sulphate of ammonia—as compared with a year ago, fully justifies this expectation. In view of the fact, however, that collieries have been seeking to obtain for contract renewals the same prices as last year, gas engineers have been adopting a waiting policy.

Since the strike early in 1912, owing to the various legislative measures that have been passed, the increased cost of consumable stores, and the several advances in miners' wages, the costs of production have considerably increased; and to protect their interests, coal owners' associations have been brought to the front again—to try and secure unity of action in regard to contract renewal and general selling prices. Most of the large producers in the various coal centres are members of these associations. Some few, however, refuse to join, and to be dictated to as to the prices at which they shall dispose of their wares. These concerns have already secured a heavy tonnage—some, indeed, now being practically fully sold—by giving price reductions which members of the owners' associations would not entertain. Obviously, it is not at all satisfactory to producers, to be compelled to sit still and see their orders taken by competitors; and there is little doubt that the arrangement colliery owners have in regard to prices has been seriously undermined by the policy of outside collieries renewing contracts at reductions of 6d. to 1s. per ton.

When trade is good, collieries can more readily stick together for their terms than when the reverse conditions obtain, in which case they are not fully loyal to arrangements in regard to prices. In more than one case large works have already renewed a good proportion of their tonnage with "associated" collieries at very substantial reductions. It would appear desirable, therefore, for gas engineers, in order to obtain the best terms, to sit tight for a short time, and we shall then possibly see a full break in the gas-coal ring, and gas engineers securing such reductions as they are able to get with full and open competition for their orders. Such a state of affairs has certainly not been greatly in evidence for the last two years. A month ago, collieries would have had little difficulty in renewing their gas-coal contracts at reductions of 6d. per ton; and indeed a number of offers on these terms were refused. But with the altered conditions it is quite possible that more favourable terms will be obtained by buyers.

As showing the largely increased use of gas, it may be pointed out that most of the big works will be in the market this year for a considerably increased tonnage—in spite of the various installations of oil and water gas—and while it would not be wise to leave too long the question of contract renewals, there is certainly no hurry for a short time. No doubt a good interchange of views will have taken place between members of the Institution of Gas Engineers at Liverpool last week, after which, on their return to business, the question of coal contracts will be gone into seriously. One thing they should bear in mind is the fact that collieries are beginning to show some anxiety in regard to orders, which is a "bear" point for the buyer.

**Partial and Intermittent Combustion of Gas.**—This subject was dealt with in a recent number of the "Journal of Industrial Engineering Chemistry" [No. 6; 1914]. According to an abstract of the article in the "Journal of the Society of Chemical Industry," mixtures of air with hydrogen and with natural gas were ignited in different ways (electrically heated wire, spark from induction coil, and gas-flame) and under different conditions in regard to volume and pressure of the gaseous mixture. Variations in these conditions led to considerable differences in the results. For the same percentage of combustible constituent and the same method of ignition, more vigorous reactions were obtained in small than in large volumes of gas, but the absolute quantity of gas burnt was greater when larger volumes were used. In a previous article, as a result of calculations, it was stated that mixtures containing more than 2 per cent. of natural gas or 5·9 per cent. of hydrogen are potentially explosive. The present experiments indicate that to produce a vigorous reaction, when using ordinary methods of ignition, only a small excess of hydrogen but a very large excess of natural gas or methane above the calculated amount is required.

# ELECTRICITY SUPPLY MEMORANDA.

**Where Electric Lighting is Cheap.**

Our electrical friends will be interested in learning of the gas experiences in Norway, where electricity generated by water power is wonderfully cheap, and 10-candle lamps (as in Bergen) can be run as long as one pleases without ever troubling to measure the current, for 2s. 3d. each a year, 25-candle ones for 4s. 11d., and 50-candle ones for 8s. 3d. They will find full particulars in a paper read by Mr. B. Schieldrop, of Bergen, before the Institution of Gas Engineers last week. Eight years ago, the Bergen Gas-Works sold 30 per cent. of its make for lighting (exclusive of street lighting); to-day, the sale for this purpose is probably less than 5 per cent. The British electrical extremists would say, if there was no contradictory information, that the gas-works of Norway must be standing on the steps of the Bankruptcy Courts, or their equivalent in Norway; because assuredly with electricity being retailed so cheaply, heating and cooking must also be done electrically. But the contrary is the case. The gas-works go on extending their business; the increase in the sale of gas never having been so great as it has been since cheap electricity competition set in. The augmentation in the sale of gas for the whole of Norway last year over the preceding year was 15 per cent.; and, for the last three years, Bergen has shown annual increases of from 25 to 33 per cent., and with a practically stationary population. The cause of all this has been the development of cooking and heating, despite the fact that all the gas coke made in Norway, and large importations of it, are swallowed up by the communities for heating purposes—the use of coal being abhorred by the people, who prefer enclosed stoves and a clean atmosphere. Electricity would stand a poor chance with its low heating value in Norway; and that is where gas scores there, and has made such remarkable progress.

**A Challenge to Electric Cooker Makers.**

A correspondent of the "Electrical Times" who has had some difficulty in getting reliable information from the makers of both gas and electricity cooking and water-heating appliances as to the relative efficiencies has, through the Editor of our contemporary, issued a challenge. He is considering the plans for fitting up a new café, and says he cannot obtain reliable comparative data upon which to base estimates of actual costs. He therefore makes an offer to makers of electricity appliances, in order to bring their goods into direct comparison with the present gas equipment in another café. It is not stated whether this equipment is a modern one, as it should be to compare with a brand-new electrical cooking and water-heating equipment. Our contemporary's correspondent is an electrical man; but he appears to be a good sportsman. If he will send the same offer to gas-stove makers through our columns, and give us his name in confidence, we do not think there would be much difficulty in obtaining the loan of the necessary modern gas appliances to pit against the electrical ones. This is suggested because we have recently seen some tests made by the engineer of an important catering company which show some remarkable savings in gas with new appliances in comparison with an older type. Besides it would hardly be fair to contrast old gas appliances with new electric ones. The correspondent says that, if the test proves that electric cooking is a financial proposition, orders for the electrification of the kitchens attached to a dozen cafés will in all probability follow. The terms of the challenge are as follows:

(*a*) Electricity will be supplied at ½d. per unit, and gas costs 1s. 6d per 1000 cubic feet.

(*b*) The contractor to supply and fix the electrical equivalent of the existing gas-cooking apparatus on a free trial for three months; it being understood that if the saving on the annual cost, reckoning interest and depreciation at 20 per cent. per annum, is not 10 per cent., then the electrical apparatus is of no use to the purchasers, and will be taken out and replaced by the existing gas apparatus at the cost of the contractor.

(*c*) During the trial period the contractor is to pay the electricity bills, and receive from the purchasers for the heat used a sum equivalent to the average of the gas bills for the same period last year, or for the preceding three months, whichever he prefers, as the gas consumption does not vary to any appreciable extent.

(*d*) The results of the test, certified by the chief engineer of the company, to be published in this paper within four weeks from the completion of the test.

Commenting on this, the writer of "Cooking and Heating Notes" in our contemporary is not particularly enamoured of the challenge—especially with gas at 1s. 6d. per 1000 cubic feet. He gives a loophole for the escape of makers of electrical apparatus by saying that he can understand they will hesitate to take up the challenge unless *provision is made for the continuous supervision of the equipment during the trial period*. Expert supervision seems to be highly essential with electric cooking appliances. If, however, there is to be expert supervision of the electrical appliances during the trial run, then it would only be fair that there should be a similar trial period of modern gas-cooking and water-heating appliances, also with expert supervision. Another point of escape provided by the writer is that no guarantee is given that the amount of cooking will not increase materially during the trial period. It is overlooked by the framer of excuses that the correspondent says that from quarter to quarter "the gas consumption does not vary to any appreciable extent." He also thinks that any maker of electrical apparatus accepting the challenge should be assured his out-of-pocket expenses. At the same time, he has confidence that electricity at ½d. should be able to compete with gas at 1s. 6d., for all the purposes of a café—baking, boiling foods, and water heating to boiling point. Then why not take on the challenge with the fitting-up of a dozen cafés in view?

**A Few Suggestions to Electrical Men.**

In the correspondence with makers that preceded this challenge, and in the electrical comments that have been made upon it, there are certain assumptions that it would be well to avoid if the writers do not want to get themselves into a muddle. It is crass stupidity for advocates of electric cooking appliances to talk at large on gas leakage and pressure variations affecting the temperatures of cooking appliances in a manner that makes a substantial difference to their efficiencies. There is a very large contradictory experience in the world; gas leakages do not exist everywhere, and gas pressures do not make meteoric variations. Gas is not so sensitive as electricity in this regard. Mr. Nichols Moore and Mr. Gillott were recently speaking about troubles with electric cooking appliances through local pressure variations. Our electrical friends might well refresh their memories as to what was said [see "Journal," May 19, p. 490]. It is also electrically assumed that for all purposes only a 40 per cent. efficiency is secured with gas cooking and water-heating appliances. This is another error. Forty per cent., or rather over, applies only to open boiling-rings on the top-plates of certain cookers recently under notice; the efficiency being obtained by simply standing over the rings an ordinary shop-purchased kettle. There is not much about such a test that savours of the laboratory. The 40 per cent. does not apply to oven work, nor to water heating on the large scale with water-circulating boilers, and other appliances. The efficiency is so good with certain of these that, if net calorific values are taken instead of the gross (as should properly be) over 100 per cent. efficiency is sometimes shown! If there are any electricians who cannot understand this, they had better consult someone who knows more than they do about heat and its measurement. Will they also please further note that 510 to 550 B.Th.U. are not the calorific values that apply to all the gas distributed in Great Britain. In many places, much higher figures obtain; and 540 B.Th.U. is the lowest calorific standard yet fixed by Parliament. It may also interest our friends to know that a very high calorific power for gas is not advisable, as, owing to the better air admixture obtained with the lower calorific power gas (lower within limits), a higher flame temperature can be secured. Perhaps this will also be incomprehensible to some of them. If, however, they take these various points into consideration, they may see that their calculations may be, as they often are, wide of the mark. Looking, too, at the correspondence, we should advise gas men to be a little more careful with their figures. It is absurd to talk of a unit of electricity giving 4311 B.Th.U. (3420 B.Th.U. is correct); and it is equally absurd to state that gas will do work in excess of its heating capacity.

**Life and Electric Fans.**

The Electricity Supply Publicity Committee is not dead. Those saying otherwise speak that which is not true. Evidence comes to hand in the shape of a letter, signed, by the aid of a typewriter, by Mr. A. F. Harrison, the Chairman, together with a specimen circular, a post-card, and a couple of advertising stamps to affix to envelopes and other places where they may be expected to attract notice and excite ridicule. Looking at these productions, the Committee have evidently not been overburdened with labour calling for grave deliberation during the year. We see by their letter-paper that they are prepared to make a little income by acting as agents for local electricity supply authorities. In addition to supplying them with posters, showcards, leaflets, booklets, postcards, &c., the Committee are willing to undertake and manage exhibitions, press advertising, and periodical circularizing. The specimen circular enclosed with Mr. Harrison's letter is intended to urge the use of electric fans. On its face is a windmill—a forlorn looking windmill—standing in the midst of terribly stormy looking surroundings, reminding of the fearful storm experienced down South on last Sunday week. There is truth in the words under the windmill, "Fresh air is life!" Opening the circular, there is a picture of five yachts, with murky sea and sky, and with a big electric-fan on shore. But the yachts appear to be travelling the wrong way, having regard to the position of the fan and the direction of the breezes it is supposed to be creating. However, it says "The electric-fan provides a helping breeze for all"—which includes the stuffy rooms in which electric lamps are used. But even electric-fans—monster electric-fans—do not satisfactorily relieve the lecture theatre of the Institution of Electrical Engineers of the stagnant air from which it chronically suffers at meeting times. The Electrical Press bears witness to this. The fan is recommended for the office, home, shop, church, and workroom, seeing that a motionless atmosphere in the office or anywhere else produces lassitude and fatigue. The fan, it is mentioned, can be used in any room of a house where the electric light is installed; the author has forgotten to state that the fan is

a necessity when a number of people are assembled at night time in an electrically lighted room. As to shops, it is said that an electric-fan invites the customer to remain, which is not desirable after he or she has been served. For churches, halls, &c., it is asserted that electric-fans are an essential part of the equipment. It may be where electric light is used, but not where gas is used. The statement, however, is also a reflection on the preachers. In the workroom, it is stated, the fan means better work and more profit. The Electricity Committee will bring the trade unions down on employers who use electric-fans if this point comes to the ears of the leaders.

**Vacuous Statements.** An electric vacuum cleaning-card is more of a comic production. A man is sitting in an easy chair, with fatuous face and prominent teeth—the combination suggesting a vacuum somewhere—while his wife, with modern dress, left hand on hip (which is not lady-like) is making a disgracefully dirty carpet (electric light is, we imagine, used in this house) look a bright red wherever the vacuum cleaner touches. But despite the evidence of the dirty carpet, an intentionally nasty knock is given as we turn over the card. "Never spring clean again," it says, and adds, "You need not; spring cleaning, horrid legacy of winter fires and gas, is now abolished in up-to-date houses." If the mission of the Electric Supply Publicity Committee is to create slatterns of our wives, daughters, and servants, and to tell untruths about gas, the sooner the work of the Committee finally ceases, the better. But we should much like to know from Mr. Harrison how the combustion of a gaseous fluid such as is used for town supply, can generate dust. There is something very greatly wrong about the vacuum card. However, it seems that, to avoid spring cleaning in the house in which the electric vacuum cleaner is used, it is necessary to "spring-clean" every week; for the Committee advise that carpets, curtains, upholstered furniture, and bookcases should receive weekly attentions from the vacuum .As to the gummed stamps, one of them shows a lady standing with her head over a steaming saucepan, her dress held up as though the floor is very dirty, and exposing a neat pair of ankles, of which a couple of half-starved looking cats are getting the best view. The other stamp depicts a sphinx with a face such as a sphinx should not possess. There is a John Bright appearance about it, with John Bright in one of his happiest moods. The cause of this is an electric-fan.

## THE GAS CHEMISTS' SUMMARY, 1913.*

Reviewed by J. T. Sheard, F.C.S.

It is only through an intimate acquaintance with its periodical literature that the technical development of a progressive industry like gas manufacture can be closely followed. Text-books soon fall out of date with the progress of invention and discovery. In regard both to the experimental sciences and the application of such science to the improvement of manufactures, the accumulation of knowledge, through observation and experiment, is increasingly enormous. In pure chemistry, the difficulties of the student in keeping abreast of this knowledge have been realized, and lightened somewhat for him, by the Chemical Society, through the publication of its admirable series of annual reports on the progress of the different branches of the science. In his little book, Mr. Hendrickson has essayed to perform a similar service for the student of the technology of gas and its applications. And by "student" I mean all who wish to learn something of whatever has been published during the year regarding improvements effected, or useful knowledge gained, by the applications of chemistry in the manufacture and utilization of gas.

The scheme of the book is to present a condensed summary or *précis* of the results of new investigations or discoveries made known during the year, and interesting pronouncements on any matters relating to the technology of gas—the whole classified and gathered together in chapters under appropriate headings. Thus the first chapter is on carbonization, and is followed by others on condensation, purification, tar and ammonia, oil gas and water gas, photometry, gas analysis, &c. In effect, it comes to this—that the author has reviewed the whole field of the chemical aspect of gas technology, in so far as it has been gone over, in print, during the year; and the result is a compilation of varied, interesting, and most useful information, and withal, considering the disjointed material from which it is made, eminently readable. The difficulties of the task were great, and it is not to be wondered at that Mr. Hendrickson has not been able to make a selection to which exception cannot be taken. But when I think of the mass of technical papers he has studied, selected from, condensed, and rearranged, so that their essential points might be presented in a few lines, the wonder to me is that he has succeeded so well. Only those who have attempted to make for themselves a synopsis of, or index to, the useful information recorded from time to time in the technical journals can realize the immense amount of labour that such a work as this has entailed.

Mr. Hendrickson proposes to continue the publication in following years, and asks for criticisms or suggestions which may help him to improve upon his first performance. The general plan of the work can hardly be bettered. As already remarked, the abstracts have to an extent been woven into a connected narrative. Sub-headings in heavy type are conveniently employed to direct attention easily to the different subjects dealt with, while numbered references to a bibliography at the end of the book show the authority or source whence any statement is derived without interfering with the continuity of the text. If I might venture on any suggestion to the author, it would be that in future he should exercise still more freely his right of judgment, and ignore extravagant, if ingenious, proposals of no practical utility, and statements of facts which have been long recognized and are generally accepted. An example of the former is found near the bottom of page 3, and of the latter near the bottom of page 12. To the extent that I have been able to test it, the book is remarkably free from errors; but on p. 68 "a ⅜-inch burner tube" should, I think, read "⅜-inch."

* "The Gas Chemists' Summary for 1913." By A. V. Hendrickson, F.C.S., &c. London: Walter King; 1914.

## NATIONAL PHYSICAL LABORATORY.

The Annual Meeting of the General Board of the National Physical Laboratory took place there on Friday last under the chairmanship of Sir William Crookes, O.M., President of the Royal Society. At the conclusion of the meeting of the Board, there was a reception of visitors, who were invited to inspect the departments of the Laboratory.

An appeal is about to be made for an increase of the present Government grant of £7000 a year towards the support of the Laboratory, and the appeal has been backed by a number of technical societies and institutions which are represented on the General Board of the Laboratory, as well as by the Royal Society, which has the general control of its administration. There can be no question as to the importance of this national institution; and the grant of £7000 per annum is certainly inadequate for the proper fulfilment of its aims. But the Government may reasonably hesitate to place a larger sum at the disposal of the Executive until it is assured that the output of research work of public utility will be considerably higher than hitherto. An inspection of the magnificently equipped buildings of the Laboratory and of the resources at the disposal of the large and capable technical staff, sets the visitor wondering what use in any sense commensurate with their size and completeness has so far been made of them. The volumes of "Collected Researches" of the Laboratory suggest an altogether inadequate return for the provision made. It appears to us that neither the equipment nor the technical staff of the Laboratory is seriously at fault, but that the administration should be taken from the academical body which at present controls it, and placed in the hands of a board of men of affairs who would have the advice on scientific and technical matters of the Councils of the Royal and other scientific and learned societies. If a fundamental change of this kind in the administration of the laboratory were made, we should anticipate that better use would be made of its resources and staff, and we should have no hesitation in that case in supporting the application for an increase in the Government grant.

Among the buildings thrown open to inspection was that provided for the testing of road materials for the Road Board and other public authorities. Little change appears to have been made here since the previous inspection, and it is not easy to judge what work has been accomplished. An attempt has, however, recently been made through the daily Press to suggest that modern methods of road construction have been largely developed in the National Physical Laboratory. We have been quite unable to find justification for this claim. We refer to this point particularly because disparagement of tar and tar compounds for road treatment appears to be a concerted policy of the inspirers of the Press notices in which the work of the National Physical Laboratory in this direction is extolled. A leading article in "The Times" of Thursday last, headed "British Roads and Foreign Visitors," truly states that other nations are coming to us for instruction in methods of road construction and maintenance. The article implies, however, that British roads in years gone by were far inferior to those of France and Germany, whereas the truth is that British roads, taken as a whole, have always been superior. Certain main roads in other countries, have, it is true, been better maintained, but the secondary roads have been far inferior.

Well-informed engineers and road users will be greatly surprised to learn from "The Times" that the chief agency that has brought about the present superiority of British roads is the use of bitumen instead of tar as the binding compound. The article proceeds: "The practical difference is that the effect of continuous heavy traffic on tar is to spread it in a series of wave-like movements to the sides of the road, whereas bitumen produces a surface that, besides being elastic and therefore stable, has remarkable qualities of endurance." We have no wish to belittle the fine qualities of native bitumen or asphalt for town pavings; but to speak of it as the chief factor in the improvement of the roads in this country is to display a lamentable ignorance of the facts. If one traverses the main trunk roads of England at the present time, nine-tenths at least of the bituminous material used in their construction and maintenance will be found to be tar. Wave-like movements to the sides of the road, of which the writer in "The Times" speaks, are due, when they occur with tar, to its improper use; and it is by no means impossible to get the

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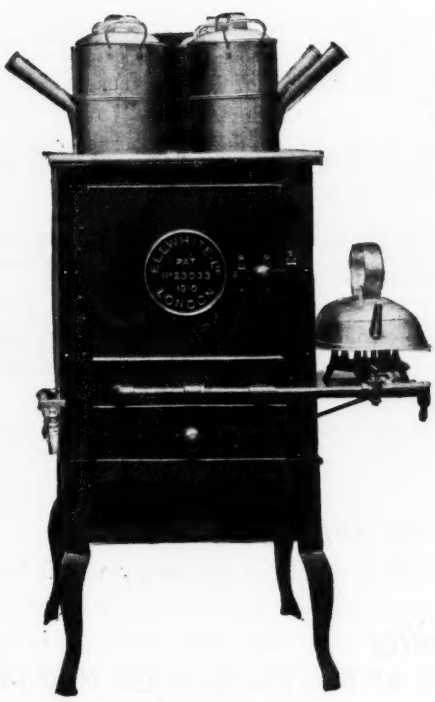

No. 2.—"Ellwhite" Gas Stove showing Plate Chamber and Hot-water Draw-off-Tap.

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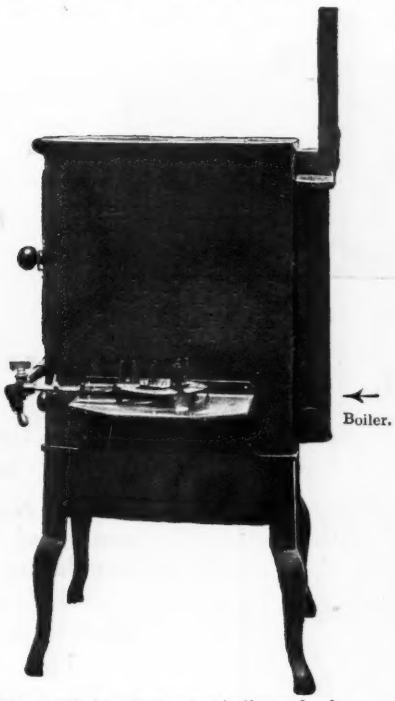


The "Ellwhite," showing boiler at back, holding two gallons of water, which is heated simultaneously with the cooking of food, at no extra consumption of gas.

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"From the brief inspection of it which it has been possible to make, the Ellwhite gas-stove appears to be an appliance deserving of consideration in connection with the purposes for which it is adapted. In the kitchen there is practically an inexhaustible field for the utilization of gas; so that there is plenty of room for new efficient apparatus. Thus there is an opportunity for this stove to occupy a sphere of usefulness of which it is sure to avail itself, if in work-a-day practice it is found to fulfil all that is claimed for it."—*The Journal of Gas Lighting*, 24th March, 1914.

"A new kind of gas oven had its 'press-view' in London yesterday. After an oven had been going for over an hour one could find no trace of blackening with carbon, either on the bottom plate of the oven immediately over the flames or in the flue or on the bottoms of the pans which came into contact with the escaping fumes. Under the burners is a deep drawer which forms part of the combustion chamber and serves for grilling and toasting."—*Manchester Guardian*, 20th March, 1914.

"The popularity of the gas-oven of sheet iron increases with knowledge of its possibilities. A fresh candidate for favour is the 'Ellwhite,' supplied by the ELLWHITE GAS-STOVE CO. (LTD.), of 25, Newman Street, Oxford Street, London, W. This is square in shape, and is supplied mounted on tall or low cast-iron legs. The gas chamber, with six 3-ft Bray burners in it, is immediately below the oven, from which it is divided by a bottom with a cast plate in it. The grilling-tray is below, and lower still is a plate-closet. A patented system of jacketed walls, heated by the products of combustion, a hot-plate with four pot holes, a two-gallon boiler at the back with a tap to draw off the water, and a bracket on the side on which a boiling-ring is fixed complete the outfit."—*The Ironmonger*, 28th March, 1914.

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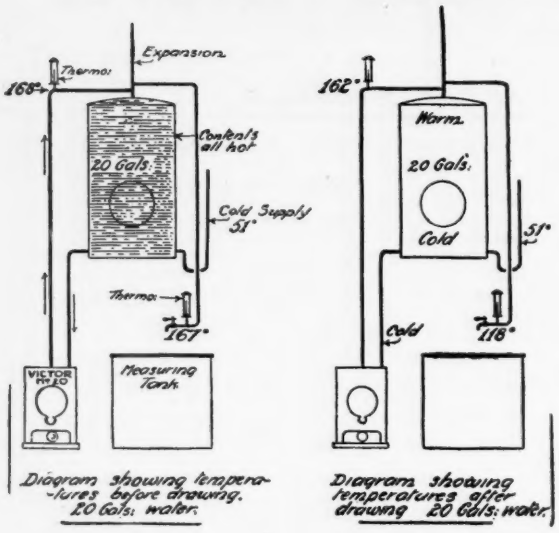


They are constructed in sections, thereby affording the greatest possible safeguard against fracture, common to large and complicated castings.

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The sectional principle upon which VICTOR BOILERS are designed enables the flow pipe from the boiler to be carried into the expansion pipe (POTTERTON'S SYSTEM), see diagram, by which means the best results are obtained, besides acting conducively to quick effect in delivery.

The apparatus heats and stores the water at a high temperature with once circulating through the boiler, which can be drawn without mixture with the bulk, the incoming cold water, or the contents of the boiler, and without lowering the temperature from any of these causes.

The diagram illustrates an apparatus before and immediately after drawing 20 gallons of water, the test being made to show by the thermometers in the flow pipes that the hot water drawn is confined to the contents of the cylinder, without partly or wholly flushing out the boiler. The apparatus is fed from a cold water cistern 26 feet above the boiler.

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same effect by the improper use of native bitumen. The road surveyors of the widest experience with the use of tar obtain marvellously good results with it; and there is no question that for the bulk of the ordinary main and secondary roads of the country tar cannot with advantage be superseded as a binding agent by any other bituminous material. This is the lesson which can be learned by anyone who chooses to make an extended tour of observation on the roads at the present time. When we learn from "The Times" article that much of the credit of the superiority of British roads is due to the value of the work done by the National Physical Laboratory at Bushey, we wonder whether reports from the Laboratory are responsible for the disparaging remarks with reference to tar made in the same article. If the Laboratory is disposed to adopt a prejudiced and unpractical attitude on an issue of so great importance as this, we opine that the gas undertakings and the tar distillers of the country will be loth to see it endowed with further funds. It must show that it is not inclined to make mischievous use of them.

## EVENT AND COMMENT.

[COMMUNICATED.]

### COMMERCIALISM AND SCIENTIFIC RESEARCH.

IT is an undoubted fact that in certain industries we are a long way behind our *confrères* on the Continent, especially in Germany. More particularly is this true in connection with those industries which call for the commercial application of scientific ideas rather than in those depending upon manual or mechanical operations. Such, for example, are the finer branches of the chemical trade and the coal-tar colour industry, and especially those industries directly or indirectly connected with the recovery and working-up of the bye-products obtained by the distillation of coal. It is not that the German race, individually or collectively, are our superiors in brain power or inventive genius, but rather is it due to the attitude of the commercial man towards scientific and technical education. The "college man," as he is called, who has received perhaps a predominance of "theoretical" education, is almost invariably regarded with contempt by the English manufacturer. There is little, if any, co-operation between the universities and industrial concerns in this country, greatly to the loss of both; and until such co-operation is an accomplished fact, we cannot hope to compete successfully with Germany in those industries which have a really scientific foundation.

Only very infrequently do we find British manufacturers prepared to subsidize a piece of research work being carried out by a private student, even when the object of such research would, if attained, be of inestimable value to the manufacturer. The latter wants to see the final result before he puts his money down. The consequence is that, owing to lack of funds, the research has to be dropped. The manufacturer is only ready to step in when the struggle is over and the desired result obtained, forgetting that if master-minds are to be devoted to the study of the various problems which arise, they must be paid adequately while the work is going on, even though the result may be of no commercial value. The attitude of the German business man on the other hand is just the contrary. Any chemist who has reasonable ideas on a piece of research work which has only indirect bearing on commercial problems is sure of support for his investigations; and if it has a direct bearing it is a very easy matter for him to ensure its financial well-being.

### ACADEMIC RESEARCH WORK AND THE GAS INDUSTRY.

THE Livesey Professorial Chair of Gas Engineering was established at Leeds with the object of correlating the academic with the severely practical side of the industry. This, together with the Research Fellowship of the Institution of Gas Engineers, ought, if properly worked, to be of enormous advantage to the industry; yet up to the present time the writer has failed to see any real utility of either post. The crowning-point in the career of uselessness of one of the posts, at any rate, is the paper submitted at this year's Institution meeting by the Research Fellow. As a piece of academic physico-chemical research, it might well have graced the pages of the proceedings of the Faraday Society; but so far as its applicability to every-day gas engineering is concerned, where does its usefulness come in? There are surely problems of more importance than this awaiting investigation. One fails to detect much sympathy or association between gas engineers and this academic institution; and we rarely hear of one being of any real assistance to the other. This is not as it should be, and the professorship and fellowship are in danger of becoming, if not sinecures, at any rate institutions for carrying out private research at the expense of the gas industry. If the gas industry maintains these institutions, it should at least see that some attempt is made to obtain value for money.

### TRIAL OF LOW-TEMPERATURE CARBONIZATION IN GLASGOW.

THE decision of the Glasgow Gas Committee to instal a trial plant for the purpose of carbonizing coal at a low temperature and producing a smokeless fuel, noticed in the "JOURNAL" for the 9th inst., has aroused much interest in gas engineering circles. The results of the experiment will be eagerly awaited on all sides, partly on account of the fact that the process to be adopted is an entirely new one and working on somewhat novel lines. A little time ago the writer had some conversation with Mr. Maclaurin, the inventor of the process, and was impressed by his keenness and enthusiasm. At the same time, he did not make any extravagant claims, and fully realized the natural limitations of any such process. Glasgow is very progressive in the matter of smoke abatement; so that enthusiasts in this direction will be able to extend practical support to an attempt to fall in with their ideals by purchasing the product of carbonization at its full market value. It has been stated in some places that Mr. Maclaurin's process will yield as much gas per ton of coal as other—and presumably high-temperature—carbonization systems. If this is so, one fails to see exactly where its advantage comes in. There is only a fixed quantity of volatile matter in the coal, and this is divided into gas and tar. If a high yield of gas is obtained, then the tar is decreased, and *vice versâ*. We cannot have a high yield of both gas and tar, unless the coke is destroyed by gasification along the lines of gas-producer practice. It is, however, somewhat difficult to express a decisive opinion on the matter without detailed information as to the working of the process; and apparently this is not yet forthcoming. Should the Glasgow experiment be successful, no doubt a full working description of the whole arrangement will be published.

## TEXAS COALS AND LIGNITE FOR GAS MAKING.

IN the "JOURNAL" for the 12th of May (p. 405), we noticed the receipt, from the Bureau of Economic Geology and Technology of the University of Texas, of a pamphlet devoted to the subject of the fuels used in the State. The authors are Messrs. W. B. Phillips and S. H. Worrell; and from the bulk of matter they present, occupying about 250 pages, we extract the following particulars relating to the coals and lignites of Texas, and their value for gas making and the recovery of bye-products.

There are three recognized coal-fields in Texas—one in North Central Texas and two on the Rio Grande. The coal of the former is of the carboniferous age and of sub-bituminous quality; and the field produces by far the greater proportion of the coal raised. The seams are not thick; no single bench running to more than 24 inches. Nearly the whole of this coal is used for railroad purposes; the remainder being burnt under stationary boilers. No coke is made from these coals, though some of them are capable of yielding it of fair strength; but it is high in ash, and comparatively so in sulphur. The coal from the Rio Grande fields is probably of the cretaceous age; and it also is sub-bituminous in quality. The total workable coal area in Texas may be taken at 8200 square miles, with an additional area of 5300 square miles that may contain workable beds, as estimated by Mr. M. R. Campbell, of the United States Geological Survey. The original supply of coal in Texas is thought by him to have been 8000 million tons. The total loss due to production and waste has certainly not exceeded 15 million tons; so that there is 99 per cent. of the original supply left. This is reckoned by the authors to be sufficient to provide for a mining loss of 10 million tons annually for 800 years. From 1895 to 1912, the quantity of coal produced was 13,367,635 short tons, of the value of $28,795,998; of lignite, 8,041,940 tons, of the value of $7,153,824. Since the first-named year the production of coal has increased by three times, and that of lignite by nearly eight times.

The following figures show the composition of Texas coals, as taken from the mines.

| | Natural Condition. | | Dry Bases. |
|---|---|---|---|
| Carbon | 60·01 | .. | 64·79 |
| Hydrogen | 4·25 | .. | 4·59 |
| Oxygen | 8·33 | .. | 9·00 |
| Nitrogen | 1·76 | .. | 1·90 |
| Heat value, B.Th.U. per pound | 11,245 | .. | 12,035 |

The ash varied from 9·07 to 24·76 per cent.; the average being 16·04 per cent. The specific gravity of Texas coals as mined varies from 1·02 to 1·51.

### GAS-PRODUCING PROPERTIES OF THE COALS.

The authors investigated the coals mined in Texas with reference to their gas-producing and coking qualities—not for the purpose of saying the last word on the subject, but to ascertain whether any of them were suitable for the manufacture of gas. There is not much coal employed for this purpose—the total quantity being less than 30,000 tons a year; and none of it is Texas coal. The demand is supplied by Oklahoma and Alabama. By far the greater part of the gas used in Texas is made by the Lowe system, or is a combination of water gas and oil gas. The inquiry that was set on foot did not involve illuminating gas at all, but was restricted to fuel gas. The candle power of the gas made from each coal was determined in an American bunsen photometer, with single or double standard candles and an argand burner. By the use of a Welsbach mantle, candle powers from 30 to 40 were observed. The equipment of the experimental gas plant consisted of a steel retort holding 2 lbs. of coal, broken to one-quarter to half an inch and dried; pipe-condensers for water, ammoniacal liquor, and tar; and galvanized iron boxes for holding

the caustic lime for the absorption of carbonic acid. The gas, after passing through a meter, was conducted into a capacious tank, counterbalanced and water-sealed. The temperature within the retort was taken with an electric pyrometera—Le Chatelier thermocouple. The wires were carried into the retort through a silica tube, tightly packed with asbestos. The temperature observed was that of the retort immediately above the coal, not that of the coal itself; and it was kept as near 600° Fahr. as possible. From the holder the gas was piped to a Junkers calorimeter and to the photometer. The heat units in the gas were also calculated from the analysis; and in many cases there was a substantial agreement between the observed and the calculated units. The following are the results of tests of dry gas, the average yield of which was 6790 cubic feet per ton:

| | |
|---|---|
| Illuminants | 2·6 per cent. |
| Carbon monoxide | 8·3 ,, |
| Hydrogen | 46·7 ,, |
| Methane | 32·6 ,, |
| Nitrogen | 7·9 ,, |
| Illuminating power | 7·1 candles. |
| Calorific value per cubic foot— | |
| Observed | 596 B.Th.U. |
| Calculated | 577 ,, |
| Specific gravity | ·410 |

In order to compare these results with those obtained in the distillation of well-known coals used in Texas for gas-making purposes, an Oklahoma coal was selected. It gave per ton 6130 cubic feet of gas having the following composition:

| | Per Cent. |
|---|---|
| Illuminants | 1·60 |
| Carbon monoxide | 7 60 |
| Hydrogen | 43·00 |
| Methane | 45·00 |
| Nitrogen (by difference) | 2·80 |

The specific gravity of the gas was ·400, the observed heating power per cubic foot 708 B.Th.U.; the calculated heating power 686 B.Th.U.; and the illuminating power 7 candles. The percentage composition of the coal from which this gas was made was as follows: Volatile combustible matter, 36·87; fixed carbon, 58·81; ash, 4·32. The calorific value was 13,090 B.Th.U. per pound. There was left in the retort 75 per cent. of good coke.

The authors did not investigate any of the coals with reference to the yield and quality of the tar and ammoniacal liquor. As some of them are high in nitrogen, they would probably yield a liquor rich enough in ammonia compounds to render the manufacture of sulphate of ammonia attractive. But this method of utilizing bye-products can be profitably applied only in comparatively large establishments, using yearly from 10,000 to 20,000 tons of coal and upwards.

One coal produced a 16-candle gas which contained 3 per cent. of nitrogen; and it yielded 7320 cubic feet per net ton. From a ton of such coal it would be possible to obtain at least 25 lbs. of sulphate of ammonia, worth 75 c. Gas plant using 10,000 tons a year could produce $7600 worth of this material, and 732 million cubic feet of gas of a calorific value of more than 600 B.Th.U. per cubic foot. The authors consider that in heat units this gas would compare very favourably with the natural gas now used in Texas, as also with the best oil or water gas.

## Fuel Gas.

The fuel gas used in Texas consists of ordinary, producer, and natural gas. According to statistics collected by the United States Geological Survey, the total quantity of city gas sold in the State in the year 1912 was 787,898,000 cubic feet, of which, 70,652,000 cubic feet, or about 9 per cent., was coal gas, and 717,246,000 cubic feet, or 91 per cent., oil and water gas. The price of the former was $1.42, and of the latter $1.21, per 1000 cubic feet. The statistics with respect to coal gas are incomplete since 1902, as they were not obtained for 1906, 1909, 1910, and 1911. For the other seven years, inclusive of 1912, the total quantity of coal carbonized was 134,982 tons, from which there were produced 63,345 tons of coke, 1,210,931 gallons of tar, and 1,235,181,000 cubic feet of gas, of which 386,671,000 cubic feet, or 43·3 per cent., were sold for illuminating purposes, at $1.69 per 1000 cubic feet, and 713,101,000 cubic feet, or 56·7 per cent., for use as fuel, at $1.36 per 1000 cubic feet. The yield of gas for all purposes was 9150 cubic feet per ton of coal; and the total value of all the gas sold was $1,543,037. The maximum amount of coal carbonized during any one year was 30,461 tons, in 1908. During this year there were sold 185,534,000 cubic feet of gas for fuel purposes. In 1912 the amount of coal carbonized was 9581 tons, and there were sold 70,652,000 cubic feet of gas for fuel. No attempt is made in this State to utilize the ammoniacal liquor. Some of the tar is distilled for roofing and paving purposes; but this industry is not extensive.

The authors made a number of analyses of gas supplied to a Texas city of about 35,000 inhabitants. It was for the most part coal gas; but a little oil gas and water gas were mixed with it. Its average composition was as follows:

| | Per Cent. |
|---|---|
| Carbonic acid | 5·5 |
| Illuminants | 7·4 |
| Oxygen | 0·9 |
| Hydrogen | 45·8 |
| Carbon monoxide | 9·6 |
| Methane | 19·8 |
| Nitrogen (by difference) | 11·0 |
| | 100·0 |

The average illuminating power was 15 candles, and the average calorific power 546 B.Th.U. per cubic foot by the Junkers calorimeter. In the city in question, the quantity of gas sold in 1912 was about 68 million cubic feet, at an average price of 95c. per 1000 cubic feet. The maximum production of fuel gas in any one establishment during 1912 was 340 million cubic feet; and the selling price was $1.

The United States Geological Survey has collected statistics of the production and distribution of oil and water gas in Texas for the years 1905, 1907, 1908, and 1912. They furnish the following particulars. There were produced 2,734,836,000 cubic feet of oil and water gas, against 803,390,000 cubic feet of coal gas; so that the production of the former gases was more than three times as great as that of coal gas. The quantity of illuminating gas sold was 874,805,000 cubic feet, at an average price of $1.28, against 171,097,000 cubic feet of coal gas, at an average price of $1.73 per 1000 cubic feet. The bulk of fuel gas sold was 1,556,313,000 cubic feet, at an average price of $1.27, as against 530,587,000 cubic feet of coal gas, at an average price of $1.34. The fuel gas, expressed as a percentage of the total, ranged from 45·7 to 62·4, with a general average of 56·9, which is almost exactly the general average for the fuel gas made from coal expressed as a percentage of the total.

The authors made a number of analyses of the oil and water gas supplied to the city already mentioned, and found the average composition to be as follows:

| | Per Cent |
|---|---|
| Carbonic acid | 2·3 |
| Illuminants | 10·1 |
| Oxygen | 0·9 |
| Hydrogen | 36·3 |
| Carbon monoxide | 28·0 |
| Methane | 6·8 |
| Nitrogen (by difference) | 15·6 |
| | 100·0 |

The calorific value was 573 B.Th.U. per cubic foot.

The consumption of fuel gas in Texas for the year 1912 was about as follows:

| | Cubic Feet. |
|---|---|
| Manufactured gas (city gas) | 787,898,000 |
| Natural gas | 7,470,373,000 |
| Producer gas (made mostly from lignite) | 3,250,000,000 |
| Total | 11,508,271,000 |

The figures for producer gas are approximate; but it is thought that the total consumption of fuel gas of all kinds during the year named was between 11,000 and 12,000 million cubic feet. The consumption during the year 1913 will probably be found to have been considerably larger.

Owing to the increasing cost of gas oil, and to some extent also to local conditions, there is a tendency towards the manufacture of coal gas. One establishment which used a combination of the Lowe system and oil, and which sold, in 1912, 68,519,000 cubic feet of fuel gas, has erected retorts for coal gas, using Oklahoma coal. In most, if not all, cities and towns using manufactured gas, the illuminating and fuel gas are conveyed through the same pipes.

No statistics have been collected in regard to the cost of manufacturing city gas in Texas; but it is likely that an average of 45 c. per 1000 cubic feet is not far from the truth. Manufactured gas is much used for domestic purposes, whereas natural gas is largely employed for industrial purposes. The heat units in the best natural gas are a good deal higher than in the best manufactured gas; but, as a general rule, there are only from 150 to 200 more units per cubic foot in natural gas than in the manufactured gas used in Texas. Many gas-engines of comparatively small horse power are run on manufactured gas; but some of those operated with natural gas and lignite producer gas are of 1000 H.P.

The authors consider that the use of the candle power as a standard for gas is of but little value in the part of the country they are dealing with, and under the conditions that are likely to continue. They say it is much to be desired that the British thermal unit per cubic foot should replace candle power as a standard for gas. When this unit per cubic foot is given, a statement should, they think, be made as to whether the figures are from direct determination in some accepted calorimeter or from calculation; the factors used being given in the latter case. As the greater quantity of gas made or produced in Texas is used for fuel purposes, the change of the standard from candle power to British thermal units per cubic foot would entail no hardships upon either producer or consumer.

[Further notice of the contents of the pamphlet is reserved for another article.]

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**Action of Water on Carbides of the Rare Earths.**—Dealing with this subject in the Bulletin of the Société Chimique de France [No. 8; 1914], M. Damiens says that when water acts upon the carbides of cerium, lanthanum, neodymium, praseodymium, and samarium, no methane is formed; the hydrocarbons obtained being acetylene, allylene, vapours of heavier hydrocarbons, ethylene, and ethane. The liquid hydrocarbons formed very readily fixed oxygen in the cold. Systematic study of the oxides shows that they are the hydrates of sesquioxides, and the reaction takes place according to the equation $C_2M + 3H_2O = M(OH)_3 + C_2H_2 + H$. The hydrogenation of acetylene gives ethane and ethylene.

# THE GLOVER-WEST VERTICAL RETORTS AT THE LINACRE (SOUTH) WORKS OF THE LIVERPOOL UNITED GASLIGHT COMPANY.

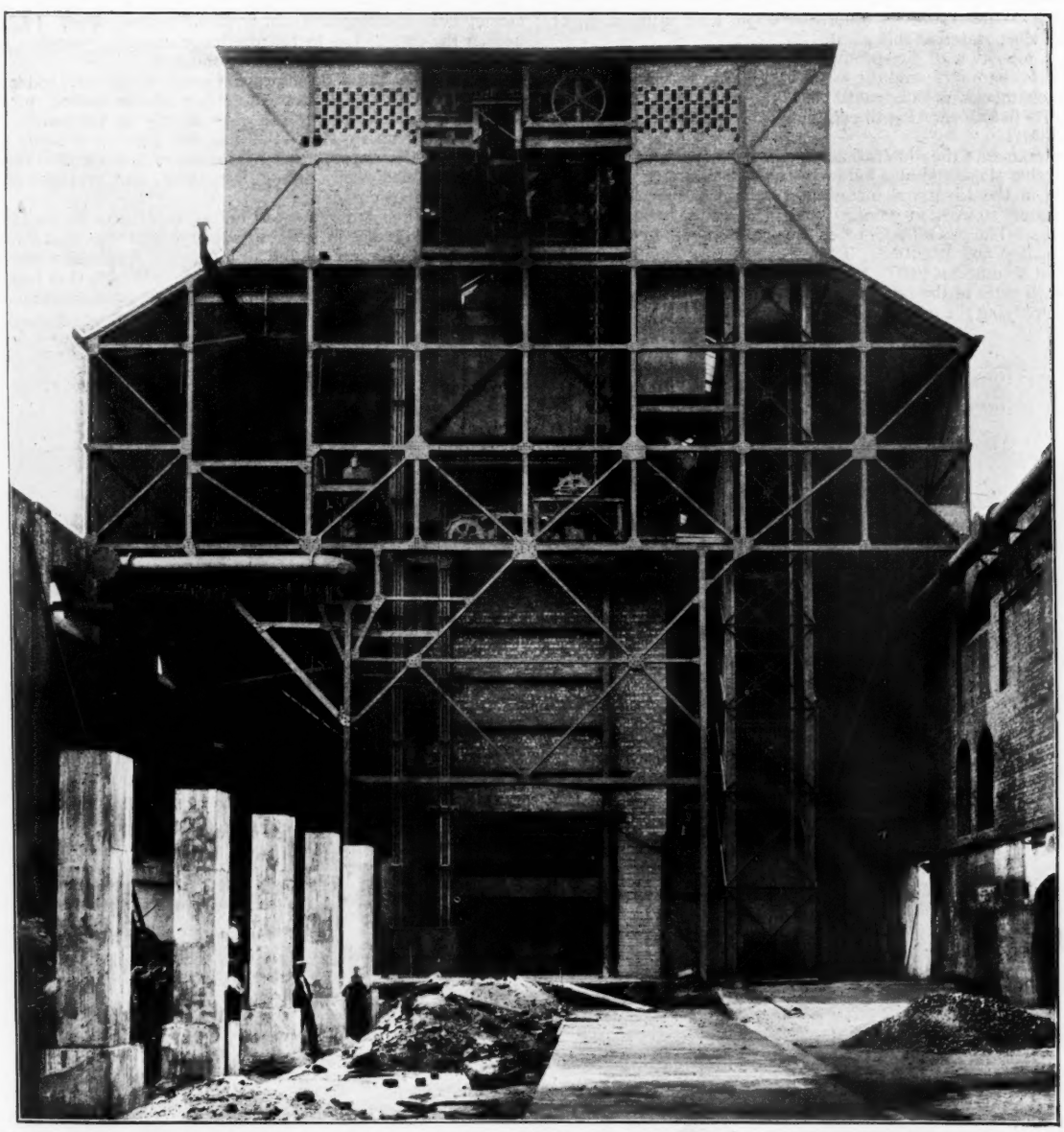
On the occasion of the visit of the members of the Institution of Gas Engineers to the Linacre Gas-Works, Liverpool, last Tuesday, the opportunity was taken to inaugurate the Glover-West vertical retort plant recently put into operation. Mr. John Bond, the President-elect, was invited by the President, Mr. Edward Allen, to officially start the mechanical operations of the plant. A number of the members assembled in the motor-house at one end of the reconstructed No. 1 retort-house; and Mr. Bond, after making a few appropriate remarks, inserted the main switches, and started the motor for driving the coke-extractors. A complete inspection of the plant was then made, including the discharging of the coke, which was transported from the retort-house to the yard store by the telpher coke-conveying plant described on p. 784 of last week's issue of the "JOURNAL."

The installation of Glover-West vertical retorts at Linacre comprises several features which are novel when compared with previously erected plants on this system. In the first place, the existing retort-house, which formerly contained one bench of horizontal retorts and one bench of inclined retorts, has been heightened by the addition of a steel framework filled in with a light screen of brickwork; the holes left for ventilation and light on one side of the building being constructed to form the letters of the motto of the Liverpool United Gaslight Company—viz., "*Ex Fumo Dare Lucem*." The new roof is of special design, and strengthened to enable it to sustain the load of the telpher track and machine for the coke-handling plant previously referred to. In this design, advantage is taken of supporting the weight of the roof on the buckstays of the retort-bench, relieving the side walls as much as possible from any vertical load due to the telpher plant.

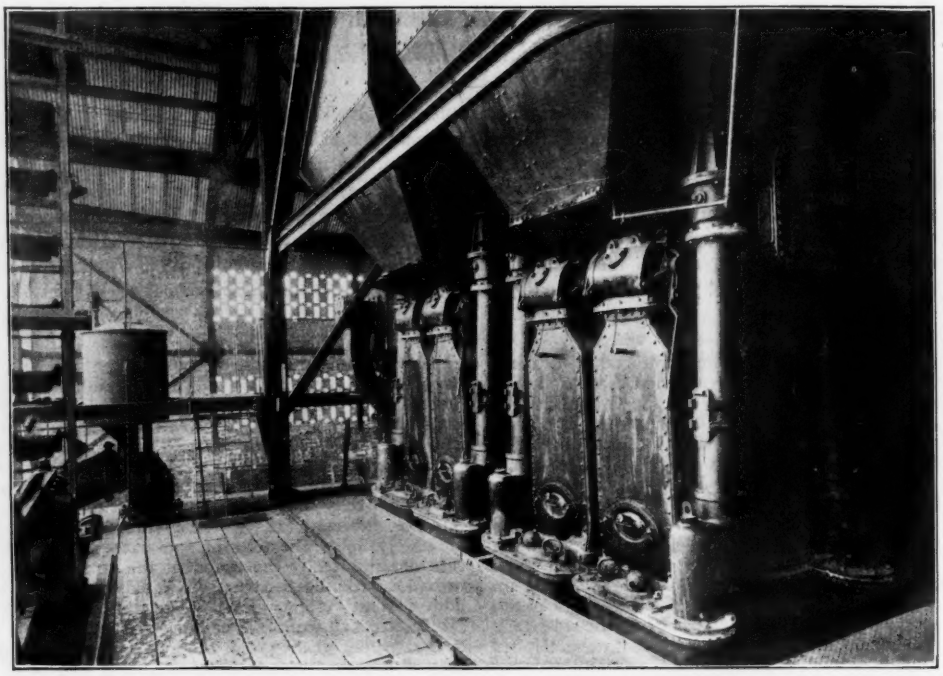
The retort-house contains at present one bench of eight settings of eight retorts; but an extension of the plant to double this capacity is now in course of construction in the same house. The capacities of these plants will be found in the table on p. 770 of last week's "JOURNAL." The coal-handling plant for this retort-house was also described in Mr. Allen's account of the works of the Liverpool Gas Company on p. 768 of the same issue.

As is general with the Glover-West vertical retort plants, there are overhead coal-storage bunkers which, in the Liverpool installation, have a capacity of 48 hours' supply to the retorts. From these bunkers, the coal falls to the coal-feed valves and hoppers immediately above the retorts, and passes through the retorts at a rate determined by the speed of the coke-extractors, which are provided with the usual speed-regulation device peculiar to the Glover-West system. The retorts are arranged in lines of four. Each setting of eight retorts is heated by gas from one producer of the stepped-grade type; the flues being arranged so that one-half, or four retorts, only of each setting can be in operation, if desired.

The Glover-West system of heating the secondary air by pass-



GLOVER-WEST VERTICAL RETORT PLANT WITH FOUNDATIONS FOR EXTENSIONS AT LINACRE (SOUTH) GAS-WORKS, LIVERPOOL.



THE COAL SUPPLY TO THE GLOVER-WEST VERTICAL RETORTS AT THE LINACRE (SOUTH) GAS-WORKS, LIVERPOOL.

ing it around the base of the retorts in such a way that the residual coke is cooled and its otherwise waste heat utilized, is, of course, incorporated in this plant.

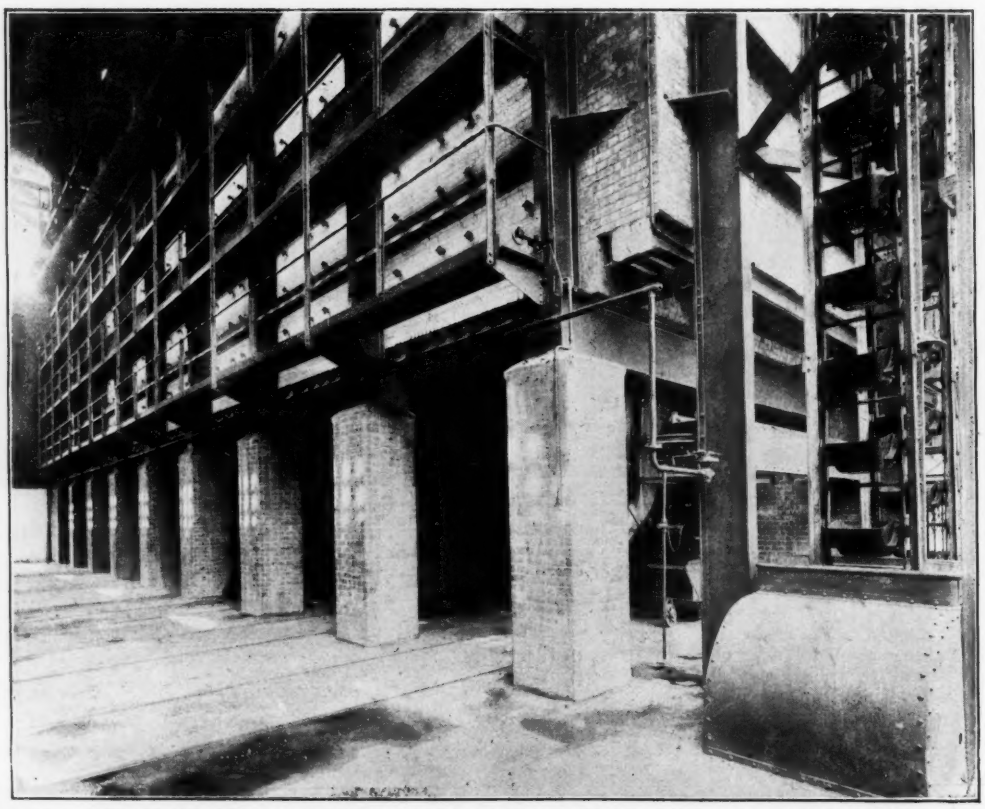
The combustion of the producer gas takes place in a number of separate chambers; and the waste gases, after leaving the combustion chambers, are caused to circulate around the top ends of the retorts before entering the chimneys, of which there is one to each setting.

By reference to the illustrations, it will be noticed that both on the charging stage and also below the coke discharging chambers there is, in the Liverpool installation, an ample space to enable the operators to work in comfort and in comparatively cool surroundings. The gas off-take pipes are provided with ready means for inspection and attention. The gas collecting mains are suspended at a sufficient height to enable the operators to pass freely along both sides of the retort-bench, and between the settings.

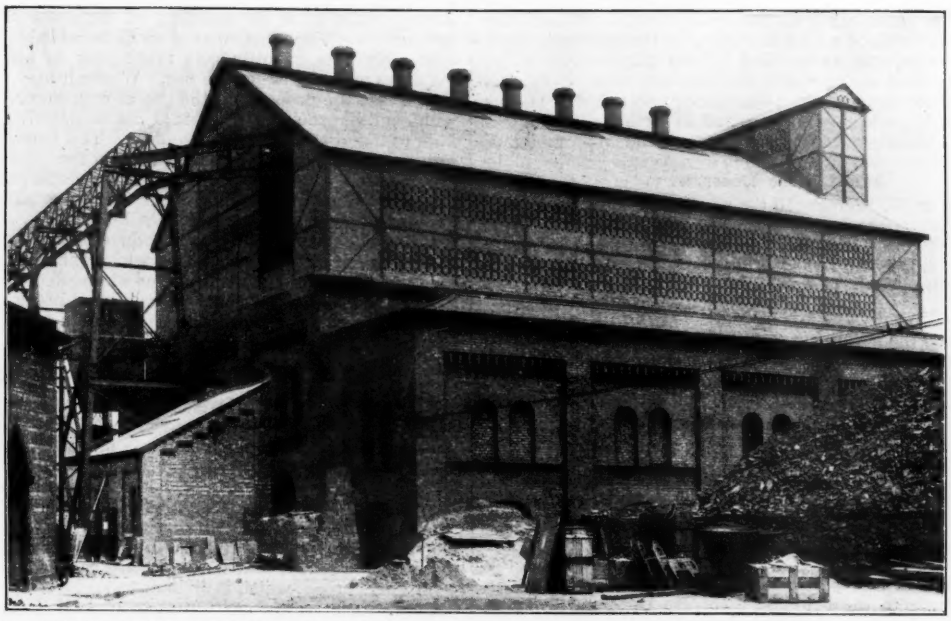
For supplying the coke to the producers, there is a coke-hopper placed outside the retort-house in a convenient position for receiving coke discharged direct from the telpher skips. From this hopper the coke is fed to the producer charging waggons which run along a track laid above the producers.

The whole of the plant is provided with stairways, ladders, and platforms; and, in addition, there is a lift for raising the coke-waggons to a hopper for the coke supply to the retorts when starting them up to work—the coke for the retorts being transported from the store hopper by means of a suspended runway. The plant is electrically driven throughout, and arranged for 220 volts continuous current.

The alterations to the retort-house, together with the foundations, the retort-bench with all fittings, and the coal-handling plant with electric motors and driving gear, has been carried out in accordance with a contract placed with West's Gas Improvement Company, Limited—the licensees for the construction of the Glover-West vertical retort plants.



THE GLOVER-WEST VERTICAL RETORT BENCH AT THE LINACRE (SOUTH) GAS-WORKS, LIVERPOOL.



No. 1 RETORT HOUSE RECONSTRUCTED FOR THE GLOVER-WEST VERTICAL RETORTS AT THE LINACRE (SOUTH) GAS-WORKS, LIVERPOOL.

# SOCIÉTÉ TECHNIQUE DE L'INDUSTRIE DU GAZ EN FRANCE.

## THE FORTY-FIRST ANNUAL CONGRESS—Paris, June 17 to 19, 1914.

## REVIEW OF THE PROCEEDINGS.

[From Our Own Correspondent.]

The Forty-First Annual Congress of the Société Technique de l'Industrie du Gaz en France was held in the hall of the Society of Civil Engineers, Rue Blanche, Paris, from Wednesday to Friday last week, under the presidency of M. Auguste Boutan, the Managing-Director of the Lyons Gas Company.

### GENERAL MEETING.

The first business was the presentation of the report of the congress held at Toulouse last year; and this having been adopted, the President of the Institution of Gas Engineers (Mr. John Bond, of Southport) was admitted as an honorary member of the Society.

#### Report of the Committee.

The President then read the report of the Committee, in which homage was paid to the members who had died during the year, particularly M. Visinet, the genial former President, and to Herr Albert Weiss, the Manager of the Zurich Gas-Works and Secretary of the International Photometric Commission. The report also showed that the Society contained 23 honorary, 687 ordinary, and 155 associate members—a total of 865; and that last year a sum of 33,850 frs. (£1354) was received from different gas companies in support of its work. The following subjects were dealt with in the report.

*International Lighting Commission.*—On the initiative of Mr. Hyde, the delegate of the American Gas Institute, the Photometric Commission, which had been occupied solely with gas, was converted last year into the International Lighting Commission; and the rules of the new organization were fully considered by a Sub-Committee who met in Berlin. MM. Masse and Vautier took part in the proceedings—the latter in the capacity of President. The object of the Commission is to study all subjects bearing upon the lighting industry and the sciences connected with it, and to establish a general international understanding on lighting questions. A National Committee will act in each country as the intermediary between the different technical associations and the Commission, to whom will be delegated ten members—four being connected with gas, four with electricity, and two representing other methods of lighting. The French Committee has been constituted of members of the Société Technique and the Syndicat Professionnel du Gaz, the Société Internationale des Électriciens, the Laboratoire Central d'Électricité, the Syndicat Professionnel des Électriciens, the Conservatoire des Arts et Métiers, and the Société Française de Physique. The President is M. Violle, member of the Institute of France; the Vice-President, M. Rouland, Managing-Director of the Paris Gas Company; the Secretary, M. Rolland d'Estape; and the Treasurer, M. Robert Ellissen. At the meeting in Berlin MM. Vautier and Masse explained the exceptional position taken by Frenchmen—both scientists and those engaged in industry—in connection with lighting questions; and they were successful in having French adopted as the official language of the Commission, the first sitting of which will be held in Paris.

*Standard Screw-Threads.*—The International Commission on Screw-Threads held their fourth sitting in Paris last November, and solved the difficult problem submitted to them—viz., the establishment of uniform types of threading which would allow of the interchangeability of the connecting parts of gas appliances. [The decisions arrived at are fully set out in the report of the Institution of Gas Engineers for the past year, given in the "Journal" for the 2nd inst., p. 639.] The British Standards Committee will undertake the production of the international standards.

*Professional Training.*—In connection with the remarks on this subject in the report, the President called attention to the excellent work which has lately been brought out by M. René Masse, entitled "Le Gaz," which was briefly noticed in the "Journal" a few weeks ago. The President characterized it as the most complete treatise which has been written upon the subject.

*Committee on Coke.*—The Société Technique has been occupied with the competition opened by the Coke Committee for the best appliances utilizing gas coke. A boiler was submitted, and, after trial, an important prize has been awarded for it. From June 1, 1912, to May 31, 1913, the French gas unions, including the Paris group, sold in France 2,084,476 tons of coke, and exported 149,589 tons—making a total of nearly 2,300,000 tons, notwithstanding a relatively mild winter. Of the total quantity, 1,480,000 tons were sold for domestic purposes—an increase of 900 tons on the sales in the preceding year, thanks to the efforts of the Committee to stimulate the use of coke in the household.

*Professional Syndicate.*—In noticing the work of the Syndicate, the Committee remark that the French Ministry do not appear to be going to proceed with their project to stamp meters, against which the Syndicate protested. Objections were likewise raised by them to the proposal to put a tax upon light; and there was almost general unanimity in opposing the incorporation of so anti-democratic a project in the Budget for 1914. It would have especially affected small consumers, given rise to serious trouble in the carrying-out of contracts, and been the cause of many difficulties. "Of what avail," the Committee remark, "would be the technical improvements which have been carried out as the result of so many efforts, and which, bringing about little by little reductions in the cost of gas, allow of its selling price being lowered, if direct taxes as heavy as those in question were to be suddenly imposed in addition to all the others in existence."

The report closed with some general remarks on the develop-

ment shown in most cases in gas undertakings. "Gas," the Committee say, "will for a long time remain the economic lighting agent *par excellence*, as testified by the greater number of installations effected each year." Heating and cooking by gas, and its application in industry, progress equally; and it is now acknowledged that when gas is utilized in well-designed appliances, it is an incomparable hygienic agent and a promoter of comfort.

### Report of the Treasurer.

The Treasurer (M. Frère) read the accounts for the past year. The assets amounted to 227,678 frs. (£9107), which was a slight falling-off as compared with those for the preceding year, owing to an increase in the sum awarded for prizes—20,868 frs. (£835), against 13,423 frs. (£537) in 1912.

### New Members and Office-Bearers.

Then followed the admission of new members, of whom there were 34, and the re-election of the retiring members of the Committee. The following are the office-bearers for the current year:

*President.*—M. Rouland.
*Vice-Presidents.*—MM. Delebecque, Kaeüffer, and Laurain.
*Secretaries.*—MM. Rolland d'Estape and G. Gautier.
*Treasurer.*—M. Frère.

## OPENING OF THE CONGRESS.

### Rewards to Meritorious Workmen.

At the opening of the congress on Wednesday afternoon, the President expressed regret that the Minister of Labour found he was unable, owing to the heavy work of his Department, to be represented at the opening meeting of the Society this year, for the presentation of the medals awarded to old and meritorious workers in the gas industry. M. Boutan remarked that "these medals show that the most modest work, done with constancy and devotion, is honoured and rewarded. Changes which have been made in plant have modified the conditions of labour of many gas workers, and have imposed upon them a change of their old habits, which were often held in veneration. They have known how to adapt themselves to the new conditions, which have meant for them less heavy labour and better hygiene. They have readily sacrificed their ancient habits for the progress of the gas industry." A good number of medals were awarded by the Government for "thirty years' service in the same company;" and they were handed to the workmen selected. The Society's prizes and medals were presented to 20 foremen and 191 workmen—old, devoted, and zealous servants in the gas industry.

### Prizes for the Best Papers Last Year.

M. Gaston Gautier read the report on the prizes awarded for the best papers submitted at the congress of 1913. Following a reference to the contributions of MM. Laurain, Rouland, and Bachelay, who (as members of the Committee) were excluded from awards, he made mention of the interesting contribution of M. Ab-der-Halden on the composition of tars—dealing with the practical conclusions drawn from it. A prize of 400 frs. had been awarded to its author. M. Chanial and M. Marconnet each received a prize of 200 frs.—the former for his paper on the conveyance of gas, and the latter for the contribution on his intensive gas-producer.

### Report of the Works Committee

#### Continuous Automatic Revivification of Purifying Materials.

On the suggestion of M. Bigeard, this subject had been considered by the Works Committee; the question having previously been investigated in Germany, and the results of an inquiry addressed to 150 works published in the "Journal für Gasbeleuchtung" of June 21 and 28, 1913.

The Committee had submitted a series of questions to twenty-four members of the gas industry—asking their advice on continuous revivification by admixture with air at the inlet of the purifiers. The interrogatories related also to the period during which this method had been used, the proportion of air employed, the increase in the quantity of hydrocyanic acid left in the gas, and any destructive action exerted upon the material of meters or gasholders by gas purified in this way.

Of the twenty-four consultants, twenty had used injection of air, while three of them had discontinued it on adopting vertical retorts. In some cases the use of added air had always been the practice; in others it had been adopted within the past twenty years. As a general rule, the quantity of air varied from 1½ to 2 per cent.—it was rarely as much as 3 per cent. Up to 2 per cent., the maximum quantity of cyanogen after purification was 10 grammes per 100 cubic metres; the average quantity being about 7 grammes (Wiesbaden). In the case of other works, there had been an increase in the quantity of cyanogen. As regards the existence of any destructive action upon meters there was want of agreement; but it appeared that nothing was to be feared in this respect so long as the proportion of air did not exceed 2 per cent. In order to combat the hardening of the purifying material, and to keep it in a proper condition of dampness, it was recommended to inject steam at the inlet of the purifier, or to add 25 per cent. of coke dust (very hygroscopic) to the material.

As a means of avoiding the hardening of the material and the presence of lumps, the use of special grids of the Jaeger type was recommended; but the handling of the material then becomes more costly. The proportion of air to be added seems to be 2 per cent.; but this quantity gets insufficient in proportion as the purifying material is kept in use. Where it may not be possible to increase the proportion, the use of oxygen, or of air enriched with oxygen, providing the cost is not prohibitive, should contribute to the solution of the problem. The combination of continuous and intermittent revivification in the purifying vessels by the injection of a large quantity of air into the purifier while the latter is out of use, would appear to give good results; and it avoids the exposure of the oxide in bulk to the atmosphere. It was likewise recommended to introduce the air into the gas close to the purifiers, after washing. Enrichment of the added air by tar from the hydraulic main proved of no effect; and it moreover gave rise to sulphocyanides. It was found better to allow the gas to pass downwards through the layers in the purifier rather than in the reverse direction.

#### Use of Finely Broken Coke in Producers.

The use of fine coke in existing gas-producers has generally necessitated a forced draught; the resistance of the fuel to the passage of air being excessive. As a means of reducing this resistance, it has been proposed to mix coal dust with the coke, and even to make a special coke by the distillation of a mixture. The benefit obtainable, however, is slight; for it entails an increased formation of clinker, and more trouble in cleaning-up the furnace. On the other hand, the forced draught results in considerable fusion of the ashes; and the latter are carried into the passages—forming clinker, which is difficult to remove.

These various drawbacks form an obstacle to the use of small coke in gas-producer furnaces, and have thus led to the suggestion and study of furnace-heating by means of separate gas-producers, capable of being used with forced draught without its attendant disadvantages, and allowing for the gas being freed from ash by a wet method. Experiments on these lines are being made and will be followed up by the Committee.

## PAPERS AND DISCUSSIONS.

A goodly number of papers were upon the programme for consideration at the meeting; and those noticed below present features of special interest.

### Storage of Coal under Water.

At the meeting of the Society in Paris two years ago, M. Masse, at the close of a paper on coal supplies, dealt with the question of its storage under water. This was the subject of a paper by M. Rolland d'Estape, who gave particulars of tests he had made of coal so stored. [A translation of the paper is given on p. 971.] They showed that unscreened coal which has been stored under water can, without special difficulty, be carbonized three or four days after its removal from the tank, and with only a little forcing of the generators. M. d'Estape explained that economy had not been sought, but that it was simply desired to avoid in future supplementary expenses entailed by the necessity, in order to be on the safe side, of keeping large stocks of coal, the handling of which was costly, and which, as the stocks consisted of coal which was from four to seven months old, do not carbonize well. M. Guillet referred to a work by Fayol in which the possibility was arrived at of keeping a stock of coal in large lumps for a number of years without fear of alteration in its character. M. d'Estape pointed out that this process necessitated having very capacious stores; that certain coals contain but few large pieces, and would have to be picked over on their arrival; that the collection of the large coal would be difficult; and that the pieces would have to be broken before they could be used in the charging-machines. The President remarked that all coals do not store equally well, and that sulphurous coals in large pieces quickly break up into small.

### Purification Methods and Material.

Two papers were submitted dealing with these subjects—one by M. Oscar Guillet and the other by M. Lebel. The former dealt with a rather singular anomaly which presents itself in purification, in the case of passing the gas successfully into three boxes; the gas not completely purified after the second box not appreciably changing in composition in going through the third one. As the result of the considerations set forth in his paper, M. Guillet concludes that for works where washing of the hydrocyanic acid by the wet process is not done, it is a mistake to install purifying plant with three passages; and that it is better to group the boxes so as to have only two succeeding passages of very nearly equal surface. He emphasizes the importance of the piping between the two groups of purifiers in the case of working with two passages, and says the pipes must be large enough to ensure the condensation of the aqueous vapour before the entrance of the gas into the second boxes. It is best to employ a syphon with continuous flow. The removal of 10 grammes of sulphuretted hydrogen produces 7 grammes of aqueous vapour. M. Guillet states that sulphuretted hydrogen and hydrocyanic acid may be found in a kind of indifferent equilibrium in proximity to oxide of iron, and that absorption cannot then take place except by very long contact. According to him, it is preferable to cause the gas to flow downwards, in order to allow of the easy removal of the coagulated material. M. Lebel's paper dealt with the substitution of coke dust for sawdust for admixture with oxide of iron in puri-

fication. [Translations of the two papers just referred to will be found in another part of the "JOURNAL."]

### The Principal Systems of Coke-Furnaces.

M. Berthelot submitted a long paper consisting of an analytical study of the principal kinds of coke-furnaces. The author dealt with their stability and economical working; and his paper was illustrated by numerous diagrams. [A full abstract of the paper will be found on p. 972.]

### The Comburimetry of Coal Gas.

At the congress of the Society in 1912, M. Grebel pointed out the value of a knowledge of the "comburivorous" power of gas—that is to say, the quantity of air necessary for the complete combustion of a given volume of gas; and he showed, as a rapid and certain means of making such measurements, a comburimeter in which he employed as an indicator of complete combustion the coloured fringes which form on the surface of a heated lead bath in an oxidizing atmosphere. These latter disappear as soon as there is no longer an excess of oxygen.

Returning to this important question, M. Grebel this year showed a new and exceedingly practical form of comburimeter constructed by the Société Industrielle des Instruments de Précision. The principle is the same; but the form has been modified in order readily to permit of observing the colours on the lead bath, and of controlling the consumptions of gas and air. The actual comburimeter is, in fact, a small gas-furnace, the specially constructed bunsen burner of which is supplied with gas measured by an experimental meter. The consumption is regulated by a needle valve embodied in the apparatus. The air can be supplied either at atmospheric pressure by ordinary aspiration through a gauged aperture the size of which may be varied, or under pressure after passing through an experimental meter provided with a needle valve. A new device allows of controlling the primary air admitted to the burner. The lead bath consists of a small cupel of refractory material, arranged above the burner at the centre of a refractory receptacle provided with suitable valves. An iron chimney with an opening in it, through which the bath can be observed, carries off the spent gases, and, if required, serves for aspirating the air. A cylinder of quartz glass mounted with asbestos, protects the burner from the outside air. The observations may be made by using a constant volume of air, and ascertaining what volume of gas is required for complete combustion, or with a constant volume of gas and then determining the volume of air required. In the latter case the air is always used under pressure.

After giving some details of the construction and working of the apparatus, M. Grebel dealt with the results of tests made by M. Bertin. The experiments were carried out in the first instance with the object of determining the sensitiveness of the comburimeter, which was found perfect—the smallest variation in the consumption of air caused the appearance or disappearance of the coloured fringes. The completeness of the combustion was confirmed with the Lévy and Pecoul apparatus. Deficiency of oxygen is more rapidly detected by the disappearance of the colours than by the reaction of carbon monoxide on iodic acid. The personal and observational errors which can be made after a little use of the instrument do not exceed 1 per cent., apart from those arising in the measurement of the gas. They depend solely on the measure of the time necessary for the combustion of a given volume of gas (0·2 cubic foot), and are less than one second in four minutes. The phenomenon is readily observed, and can be repeated at will.

M. Bertin has made comparative tests, using air as required and also a constant volume of air. These have permitted of the calculation of the volume of air supplied to a burner when the air is aspirated; and they have shown sufficient concordance between the results obtained by the two methods. In another series of tests, the aim was to show the relations between comburivorous power, calorific power, and density. From the experiments carried out it cannot be said that very definite conclusions have resulted; a change in the composition of the gas producing different effects upon these three characteristics.

In its present form, a comburimeter affords a certain means of determining the quantity of air necessary for the complete combustion of a given gas, and thus may frequently be applied in circumstances where such knowledge is of importance—for example, in the case of burners supplied with air under pressure, when it is desired to ensure combustion in certain conditions, oxidizing, reducing, &c. Measurements of the comburivorous power of gas may also be rapidly made, using a constant volume of air, as a criterion of quality, and the comburimetric method may be thus applied, as is the Giroud tester, in controlling manufacture. But the advantage of M. Grebel's apparatus is that it allows of such control being carried out in the case of widely different gases, including those which are non-luminous, and which would not yield useful indications when tested by the ordinary instruments as those of Lowe, Giroud, Methven, and others. The method is shortly to be applied to testing blast-furnace gas.

### Prevention or Removal of Naphthalene Deposits.

The methods employed at the Angers Gas-Works for the prevention or removal of naphthalene deposits were described in a paper by M. de la Boulaye. In dealing with the naphthalene deposits in gas-mains, which are found to occur chiefly in the autumn, and almost always at the same points, he indicated the various means he had successively employed. These he classed as mechanical and physical. Of the former, the use of a jet of steam in the main proved excellent at the time, but disastrous later. The naphthalene melts, the liquid runs down to the lowest points, and there solidifies into a hard mass, increasing at each operation, and requiring to be removed by hand. In the use of boiling water, naphthalene is freely dissolved and carried down towards the syphons; but as the water is cooled by the mains, the naphthalene again deposits as a compact mass. Cold water in quantity carries away all naphthalene not adhering to the main, and leads to no ulterior difficulties. The disconnection and brushing-out of the mains is a costly method, to be employed as a last resource.

Of the physical methods, M. de la Boulaye mentioned first the distribution in the mains of a liquid or volatilizable solvent of naphthalene, with which, after solution, it would find its way to the syphons. Such solvents are methyl and ethyl alcohol, and "gazeine" (light petrol spirit). The last-named, in the case of a quite circumscribed stoppage, gave good results provided the main could be plugged with a bladder at a point below the obstruction, in order to allow of contact with the naphthalene for an hour or two. Gazine may also be used for the continuous carburation of the gas—a plan which affords good results. The large mains in the neighbourhood of the works are rapidly cleaned-up and keep in good condition; but the gas acquires a characteristic unpleasant odour.

A further plan was that already employed by M. Ab-der-Halden—namely, atomization of heavy benzol. M. de la Boulaye found that, at 13° C., 100 grammes of gazine dissolve 6 grammes of naphthalene, and 100 grammes of heavy benzol 13 grammes of naphthalene. The solubility increases very rapidly with the temperature. The benzol is distributed into the gas by means of an atomizer almost identical in size with perfume vaporizers. The process yields very satisfactory results; but it cannot be used where there are any rubber joints. Another excellent solvent is heavy oil heated to 150° C., as employed in the naphthalene washers. On cooling, the naphthalene is held in solution without fear of solidification. The only drawback to its use is its viscosity. For stopped branch pipes M. de la Boulaye suggests the forcing-back of the naphthalene into the main by compressed air or by washing with benzol.

In the discussion which followed the paper, M. Freysse said that as the result of the work done by Bunte in 1899, the advice had been given not to use benzol but xylol, the solvent power of which (as a liquid) upon naphthalene (as a solid) was as good. In the use of vaporized xylol, a double purpose was aimed at—viz., to dissolve the solid naphthalene from the mains and the naphthalene vapour from the gas. Good results had been obtained in the first case, but less good in the second; and he had therefore been led to try other solvents, chiefly light petrol spirit, which, however, was too volatile. M. Guillet remarked that if any one had trouble with naphthalene it was because he wished to have it. If they wanted to remove the naphthalene they had only to condense quickly, which would remove nine-tenths, and employ a naphthalene washer, which would take out the rest. He mentioned a very certain process, with which he had recently experimented, for the clearing of mains completely choked by naphthalene in flakes. It consisted in pouring into them paraffin oil, which crept along the walls and dissolved the naphthalene.

### Conveyance of Gas to Long Distances.

M. de la Boulaye submitted a paper furnishing precise details in regard to a plant for the conveyance of gas at high pressure from the Angers Gas-Works to the town of Ponts de Cé, about five miles distant. The plant comprises a high-pressure station, which draws gas directly from the holder at Angers to force it through a special main into a storage holder, from which it is sent out through an ordinary regulator to the town. The plant comprises two Roots compressors, with a capacity of 100 cubic metres (3500 cubic feet) per hour, driven by 3-H.P. electric motors working with continuous current at 110 volts and 35 amperes. The requisite power per cubic metre is 27 watt-hours. The starting rheostat is completed by an automatic switch worked by the boosting pressure by means of a mercury contact pressure-gauge regulated to stop the motors when the gasholder is full. The maximum pressure is 83 inches. A double-action safety regulator allows of the return of the gas to the suction main in the event of a vacuum being made, and opens in the opposite direction, under a specified pressure, in case of obstruction in the pressure main or when the holder is full. A rotary meter placed on the suction main and a retaining valve preventing return of the compressed gas in the event of stoppage of the compressor complete the plant.

The pressure main is constructed of seamless hammered steel pipes tarred inside, and covered with an asphalted jute jacket, 20 to 30 feet long, with caulked lead joint, and tested under a pressure of 13 inches of mercury. At intervals Gibault joints have been made, so that the main can be easily divided into sections for inspection or cleaning. The syphons are of the ordinary type, without hydraulic seal, and with a cock at the higher part. Emptying is effected by pressure of the gas. The main has ten elbows, nine of them being fixed at a right angle. The loss of head, with a delivery of 2700 cubic feet of gas per hour is 0·05 inch. Comparison of the rotary meter with the one at the works shows the leakage in transit. The gasholder (a single-lift) is of 17,600 cubic feet capacity, and gives a pressure of 56-10ths. The inlet-main is provided with a kind of automatic flap-valve maintained by a counter-balance weight carried by the holder, which ensures self-closing. An automatic pressure-regulator

serves two chief mains respectively five and three miles long. The staff consists only of the watchman for the holder station; and he also acts as lamplighter and syphon-keeper.

In the discussion upon the paper, M. Payant observed that the St. Quentinoise Company had put down a similar high-pressure line for the conveyance of gas to a distance of 3½ miles from their Chantilly works. The compressor, with a delivery of 3530 cubic feet per hour, compressed to 48 inches of water. It was installed half-way between the works and the gasholder, and was driven by an electric motor directly from the works. The plant had been running satisfactorily for three years. M. Grebel called attention to the fact that, under the instructions of M. Mallet, he put down in 1895 a similar line for the conveyance of gas to Fin d'Oise. If M. de la Boulaye found, as did M. Chanial in the case of the Firmigny line, a difference between the calculated and the actual delivery of the mains, it was because he employed the Monnier formula, in which the coefficient 0·86 was erroneous for this kind of distribution. Taking the coefficient 1, which he (M. Grebel) employed to construct his abacus, there would have been perfect harmony between the calculated and the actual delivery. Replying to a question by the President, M. Grebel pointed out that the employment of storage gasholders gave greater security than forcing the gas direct to pressure-reducing regulators. With regard to these, he said he knew of some which had been working nineteen years without getting out of order.

[In addition to the papers already noticed, a number of others, mostly short communications, were read. Abstracts of them have been prepared by our Correspondent; but, owing to the pressure upon our columns to-day, their publication must be deferred.]

### Destruction of Cast-Iron Mains.

There were on the programme four subjects for discussion—viz., gas generators, the employment of small coke, the prevention of naphthalene deposits, and the causes of the destruction of cast-iron mains; but only the one named above was dealt with. M. Bigeard described how a cast-iron main 2·1 inches in diameter and about 330 yards in length, which had been in position for a long time, had to be replaced because it was completely obstructed by a rust-coloured earthy deposit for a length of 50 yards. He had analyses made of the sound and damaged parts, and also of the deposits. The latter contained 40 per cent. of iron, 7 per cent. of sulphur, 13 per cent. of silica, 26 per cent. of organic matter, and 3 per cent. of phosphorus. The sound iron contained 0·56 per cent. of sulphur and 0·96 per cent. of silica; the damaged iron, 1·7 per cent. of sulphur and 1·2 to 1·5 per cent. of silica. Without being able to explain the phenomenon very precisely, his advice was that the evil might be due to sulphur in the cast iron in the form of sulphide, which would give, by oxidation, the free sulphur found in the deposit. M. Henry, Engineer of the Pont-à-Mousson Blast-Furnaces, said he considered, after examination of the iron and analysis of the deposit, that the composition of the pipes had nothing to do with the obstruction. The 40 per cent. of iron in the deposit consisted of hydrates of protoxide and peroxide, sulphides, ferrocyanides, and sulphocyanides. There was a proportion of sulphur and silica exceeding that which cast iron could contain. Consequently, he was led to believe that the silica might have been carried forward in the pipes through badly-made joints, &c., and that the attack of the metal and the sulphur were due to the gas. He added that the case mentioned by M. Bigeard was, so far as he knew, a solitary one. Nevertheless, M. Bachelay and M. Rey said they had met with similar cases. The latter expressed the opinion that these deposits really resulted from imperfect purification at a certain moment, and were due to the action of sulphuretted hydrogen and cyanogen on cast iron. Pipes of considerable dimensions might be thus attacked. As this is a very important question, it will be discussed again next year, by which time M. Bigeard will have obtained further information.

### VISIT, BANQUET, AND EXCURSION.

On the afternoon of the opening day the members visited the works of the Paris Gas Company at La Villette; and the next evening assembled at the Grand Hotel for the usual banquet. At the close of the Congress on Friday morning, a number of them left Paris by special train for Lyons, to visit the exhibition and works of interest in and around the city.

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**Acetylene an Explosive.**—By an Order in Council acetylene has been decreed to be an explosive within the meaning of the Explosives Act, 1875. It is therefore ordered that it shall not be manufactured, imported, kept, conveyed, or sold except when it is mixed with air in a proper burner or contrivance.

**High-Pressure Gas Lighting in Paris.**—An article appeared on p. 776 of last week's "JOURNAL" dealing with the development of high-pressure gas lighting in Paris; and particulars were given of the number of lamps installed. Though, no doubt, these figures were correct at the date referred to—that is, the end of last year—it is pointed out to us that they may give rise to misunderstanding. As a matter of fact, of course, since that time the James Keith and Blackman Company, Limited, have, after severe competition with other firms, supplied for the public lighting of the City of Paris 250 2000-candle power and 45 4000-candle power lamps, in addition to those previously alluded to. These lamps have provision for automatic lighting up by an increase of pressure; the extinction being effected by a drop of the pressure to the normal.

## PURIFICATION METHODS AND MATERIALS.

Two papers read at the congress of the Société Technique du Gaz, held in Paris last week, had for their subject the question of purification. One by Mr. Oscar Guillet described a system of purification; while the other—by M. Lebel—briefly dealt with the use of inert material in admixture with oxide of iron.

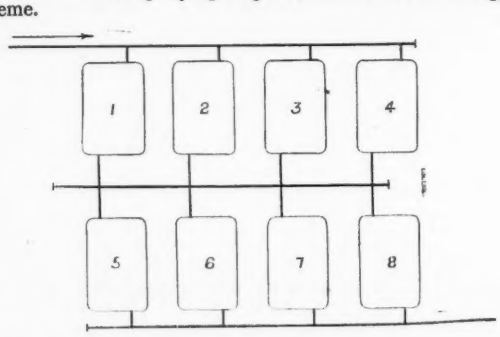
### Some Anomalies in Purification.

M. Guillet referred to the anomalies often experienced in the purification of gas distilled from English coal rich in nitrogen. It was often found that in works where the gas passed through three successive stages of purification any residue of impurity left after the second stage was not appreciably removed in the third stage. This phenomenon had occurred in his own practice to such an extent that he was led to think that, in works where the cyanide constituents of the gas were not removed by washing, if purification was not complete at the second stage it was very often not possible to remove the sulphuretted hydrogen. He believed that this fact was capable of explanation by the existence of a certain proportion between the hydrocyanic acid and the sulphuretted hydrogen in the gas, under which conditions the latter impurity did not act upon the oxide of iron. The hydrocyanic acid, in fact, behaved in the manner of a strong mineral acid, decomposing sulphide of iron and liberating sulphuretted hydrogen. There was thus nothing paradoxical in the existence in a gas of sulphuretted hydrogen without action upon oxide of iron exposed to it. On the other hand, the absorption of hydrocyanic acid by peroxide of iron was practically *nil*. Absorption takes place actively only in presence of oxide or salts of iron in the ferrous state.

It is noticed, when shavings are added to the material in the purifiers, that their colour becomes bluer (more charged with cyanide) than the material itself. The cause is probably some reduction of the iron peroxide to the ferrous state, with consequent absorption of hydrocyanic acid. From these considerations it is understood why a gas containing a little ammonia is purified more readily than one which has been thoroughly washed. The particular proportion of sulphuretted hydrogen to hydrocyanic acid is not regularly maintained, since the two impurities are absorbed at the same time, but at different rates, according to the external conditions. Those who use an added proportion (about 2 per cent.) of air in the purifiers would have noticed that while the material, during the first stage, is black, it is greyish-white in the second stage, showing the presence of ferrous cyanide, which on prolonged exposure to the air becomes of intense blue colour. The sulphur was retained almost completely in the first stage, and a greater or less proportion of hydrocyanic acid at the second stage. Where hydrocyanic acid was removed by the wet method—for example, by washing with ferrous sulphate and ammonia—no anomalies were observed. If purification was not complete at the second stage, it did ultimately become complete. It was not a case of equilibrium, as in the method already referred to. The washing removed practically the whole of the hydrocyanic acid from the gas.

### A New Arrangement of Purifiers.

These considerations led M. Guillet to conclude that in works where hydrocyanic acid is not removed by the wet method it is a mistake to employ three successive sets of purifiers. The vessels and the material are much better utilized by arranging them in two groups; the surface offered to the gas being thus proportionately increased. If cyanide is removed by washing, the use of a third set of purifiers may be justified; but in these circumstances purification takes place so readily that two sets of vessels are amply sufficient. The arrangement of purifiers on these lines is shown in the accompanying diagram, which embodies a suggested scheme.




The first and second stages of purification are similar, each being effected by four vessels arranged in parallel, and each of 12·50 square metres (134·4 square feet), or (say) 50 square metres (538 square feet) for each of the two stages. Each purifier of the first stage delivers gas into the vessel of the second stage corresponding with it; but the intermediate connections are joined from one end to the other, so as to equalize the pressure. At the inlet the gas is entirely freed from hydrocyanic acid by washing with ferrous sulphate, about 2 per cent. of air being then supplied to it by a pump. The material used is an oxide made by chemical precipitation, used without additions, such as shavings or sawdust,

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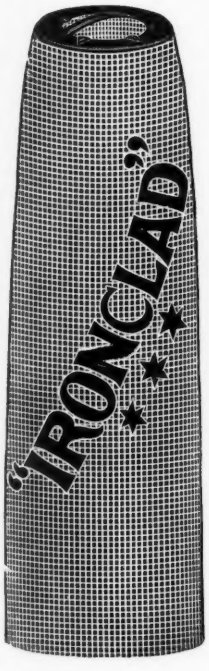

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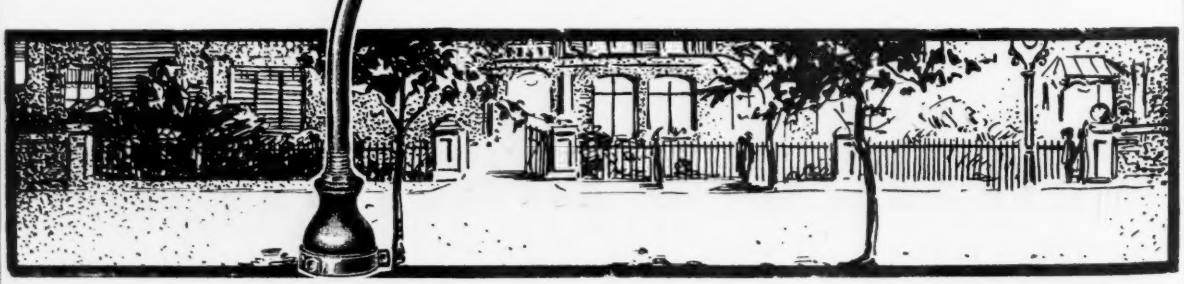

and in a layer about 60 cm. (24 inches) in depth. The quantity of gas purified is from 1200 to 1500 cubic metres (42,400 to 53,000 cubic feet) per 24 hours.

All the purifiers being assumed to be charged with fresh oxide, it will be found at the end of (say) one, two, or three months that vessel No. 1 allows foul gas to pass; the time depending upon the outside temperature and the different rates at which the purifiers of the first stage become more or less charged. The gas for the most part will pass through vessel No. 5, in which purification is completed. It is the gas from the outlet of this vessel which is thenceforth tested without troubling further with that from No. 1. As soon as it is noticed that the gas from No. 5 shows a tendency to impurity, No. 1 is cut out of the series and the contents are removed. By working in this way there is no practical danger of exceeding the limit of impurity, since the gas at the outlet of No. 5 represents only one-fourth of the total production. It should be added that in the case of all the vessels the gas enters below. The reverse arrangement would perhaps be better; but the installation had to be used as it was.

On uncovering vessel No. 1, a top layer of greater or less thickness, and generally very dry and powdery, is found to consist of red oxide almost unaltered. It is thrown out on to a spot near the purifier. Below this layer is found another of blackish hard character, requiring the pick to break it up. On testing it for sulphur, it is found to contain from 50 to 55 per cent. It is thus fully saturated, and is added to the stock of spent oxide. The purifier is then recharged, first with the powdery oxide, and afterwards with fresh oxide, and then brought into use again. As soon as it is in action, vessel No. 5 again yields clean gas; and it is sufficient to repeat this series of operations with each pair of purifiers, as opportunity offers, in order to ensure the constant production of well-purified gas. A fact to be noted is that vessel No. 5, which had begun to sulphurize at the end of the first phase, automatically renews itself when No. 1 is again taken into use, with its fresh charge, and commences to deliver gas completely free from sulphur, but still containing a very slight excess of oxygen. This vessel, and those of the second stage, are always damp and almost without any trace of sulphuration. M. Guillet records the instance of one which remained in use 400 days without being opened, and then, on being examined out of curiosity, was found to be in perfect condition. The purifiers receiving only gas which has been almost completely purified do not, in fact, require to be opened throughout a series of years. He would not venture to give a number which might appear ridiculous.

Graphic curves, showing the changes taking place in the purifiers, indicate that when vessel No. 1, at the end of six weeks, has begun to pass foul gas, No. 5 is slightly sulphided, and after ten or eleven weeks it may be concluded that the gas coming from it would not be sufficiently pure. At this stage No. 1 is emptied and recharged, yielding gas which is not only purified itself, but is capable of desulphiding the material of No. 5, which after about fifteen weeks reaches its original state again—the cycle of operations repeating itself. If, however, the hydrocyanic acid is not first removed, it is not possible to carry out the system. In these circumstances, the sequence of changes is the same as that already described up to the renewal of vessel No. 1. But following this renewal, the gas entering No. 5 would liberate the sulphur previously absorbed, owing to its content of hydrocyanic acid; and thus the gas at the outlet of No. 5 would be open to suspicion at the time of the renewal of No. 1, and would become positively sulphided as soon as this vessel was again in operation. To avoid this, it would be necessary to open No. 1 as soon as the gas yielded by it showed a suspicion of impurity—say, after six weeks in the example already quoted. Then the second stage would not proceed normally; it would only be a measure of security intended to guard against anything unforeseen.

### Advantages and Working of the System.

The advantages claimed by M. Guillet for the system are as follows:

1.—No material is exposed for revivification; and no buildings are necessary beyond those required for the storage of the fresh and spent oxides.

2.—The purifiers are always at their maximum power, since they are always charged with fresh material and all are working—vessels out of use for renewal being rarely seen.

3.—Economy of manual labour; the material from its being charged fresh into the purifiers to its removal when saturated being handled only once.

In the application of the system some experiment is necessary to ascertain the proportion of air which gives a suitable agglomeration of the oxide. With too little air the reaction is not sufficiently energetic and the material remains powdery, and does not become of such richness in sulphur that it can be treated after one single use in a vessel. The purifiers of the first series are always considerably above the outside temperature. This is an indication of good working. If it is feared that the material will fire on the removal of the cover, the purifier can be thrown out of action for 24 hours before opening; the contents cooling down in the meantime. In winter, or whenever the temperature may be very low, the reaction is less energetic, and it may be of advantage to supply artificial means of heating the gas in order to bring about satisfactory agglomeration of the material. The latter will not give rise to back-pressure, for the purifiers will register 20 to 30 mm. (8-10ths to 12-10ths); the material drying as it becomes sulphided. Dry oxide in the powdery form yields a result which is as good as the moist oxide. There is no need to dry the material on its removal from the purifier. In cases where the gas enters the purifiers at the upper part, handling of the unattacked oxide may doubtless be avoided by removing only the hard surface portion and replacing it by fresh oxide; but the plan is one of which M. Guillet does not write from practical experience.

### Results on a Working Scale.

As showing the advantage of his system in practice, M. Guillet quotes the results obtained upon a working scale (about 35·3 million cubic feet of gas), in comparison with those realized by other methods. The figures represent workings at intervals of three years, in each case at the same time of year; the temperatures being chosen as nearly comparable as possible. In the case of each test, the period covered was six months:

Ordinary purification: One vessel purified 17,425 cubic metres (615,100 cubic feet) of gas.

With use of 2 per cent. air: One vessel purified 75,148 cubic metres (2,653,000 cubic feet) of gas.

Hydrocyanic acid washed out and with use of 2 per cent. of air: One vessel purified 142,800 cubic metres (5,000,000 cubic feet) of gas.

The dimensions of the vessels were 3·4 by 2·4 metres (11 ft. by 7 ft. 9 in.); and the depth of the oxide was 0·6 metre (24 inches), representing a bulk of about 5 cubic metres (177 cubic feet). Of these, about 3 cubic metres (106 cubic feet) were treated for the recovery of sulphur; the other 2 cubic metres, non-attacked, remaining in use. The conditions throughout the three series were the same, excepting that during the first the oxide was mixed with shavings—a somewhat deeper layer being used. The quality of the purification during these three periods underwent steady improvement, becoming excellent at the end.

### Broken Coke as a Substitute for Sawdust.

M. Lebel, in a brief note, dealt with the use of finely-broken coke as a material for admixture with oxide in the purifiers, in place of sawdust. In addition to its drawback of inflammability, sawdust is difficult to combine with the oxide, in consequence of the great difference in the density of the two materials. Further, its colour being similar to that of the oxide, control of the mixture by this means is impracticable. As a substitute for the sawdust, M. Lebel makes use of finely-broken coke, consisting of pieces ranging from 8 to 12 mm. (0·3 to 0·5 inch) in size; this mixture with the oxide avoiding the drawbacks of sawdust, and affording results equal to those with vertical "Bamag" grids at a much lower cost in the first instance and for subsequent manual labour. In comparison with sawdust, the advantages of the broken coke are thus stated:

| *Sawdust.* | *Coke.* |
|---|---|
| Difficult to mix with oxide, and impossible to adjust mixture by colour. | Mixes readily with oxide, and the mixture can be adjusted by colour. |
| Slow but steady increase in resistance to the gas; making it difficult to ascertain complete exhaustion of the material. | Increase of resistance to the gas inappreciable at first, suddenly becoming greater when the material is near exhaustion; thus showing very exactly when the oxide requires to be revivified |
| Necessity of making one or two revivifications of fresh material before securing regular purification of the gas. | Material works regularly from the start. |
| Material rapidly hardens into large masses, requiring the pick when emptying the vessels. | The grains of coke of the size named prevent the formation of hard masses. |

The mixture which appears to be the best in use is that consisting of equal parts by bulk of oxide and coke—that is to say, when using peroxide of iron containing a fair proportion of clayey matter and of yellowish shade. With purer oxide, it might be of advantage to employ less coke, in order to increase the purifying power of the material per cubic foot.

## STORAGE OF COAL UNDER WATER.

By M. Rolland d'Estape.

**[A Paper read before the Congress of the Société Technique du Gaz.]**

When coal is stored under water for the sake of its better preservation, there obviously comes a time, sooner or later, when it is necessary to carbonize it. This wet coal cannot be expected to behave, either in handling or in the retorts, precisely in the same manner as dry coal; hence the results contained in the present paper in respect to coal which had been stored in this way may be of general interest. They represent the experience gained on a working scale with coal stored under water in a large receptacle for a number of months. This holder has a capacity of some 4000 cubic metres (141,270 cubic feet), equivalent to about 3200 metric tons of coal. It is circular in shape, resembling a gasholder tank in appearance. It is constructed of re-inforced concrete, and is

placed above the ground. Its height is 10 metres (33 feet). At 1·8 metres (6 feet) above the ground, the maximum thickness of the wall is not more than 0·75 metre (30 inches), while the floor is only 0·12 metre (4·8 inches) thick. Level with the ground there is an aperture in the wall measuring 1·80 by 1·50 metres (6 ft. by 5 ft.), closed by a metal door, and designed for the removal of the coal. Provision is made for running off the water by two pipes, each fitted with a valve, 150 mm. (6 inches) diameter, and further closed by means of a joint.

### Above-Ground *v.* Under-Ground Tank.

Much consideration was given to the question of building the tank above or below the level of the ground. Below ground is the plan which perhaps seems the better at first sight. It avoids an ugly building, and is more convenient for the delivery of coal and water into it. Moreover, the space occupied by the immersed coal can be used for the storage above it of coal kept in the air in the ordinary way. But, on the other hand, the sunk tank entails pumps for the removal of the water, and it is likewise less easy to take the coal from it. These drawbacks are of some special importance, since the tank is charged with coal under ordinary conditions, but has to be emptied usually in circumstances when the coal is wanted quickly. As regards the positioning of the tank above the ground, there is the advantage of much readier attention to its water-tightness. Our choice of the above-ground tank was, however, finally decided by the combined considerations of safety and economy. In a tank such as this, which requires to be water-tight, and is sometimes full, sometimes empty, the structure should be capable itself of resisting all the stresses to which it may be subjected without relying in any way upon the relief afforded by the surrounding earth. This was the more necessary in our own case, since the ground in our works is bad, and the level of water below the surface extremely variable. Thus the tank required to be built in the same way whether placed below or above ground. In the latter case, one would save the cost of excavation and the greater cost of masonry (necessary owing to the slight depth at which water occurs) as compared with reinforced concrete. It may be added that the tank was built under excellent conditions, and has not suffered in the least from leakage.

The tank was for two-thirds of its depth charged with coal as ordinarily used, and on the top third with three different kinds—(1) coal as ordinarily used, (2) coal freed from all fine dust, and (3) coal in small pieces. These three varieties occupied sectors, each one-third of the top layer.

### Tests of the Immersed Coal.

Some preliminary tests showed (1) That coal, even when immersed to a considerable depth under water, is not penetrated by the water to any appreciable extent. The quantity of water absorbed is negligible. In the most favourable circumstances the proportion of absorbed water was not more than 0·7 per cent. (2) The quantity of water which adheres to the coal after immersion varies with the size of the coal; being greater in proportion to the fineness of the coal. Fine coal retains about 15 to 20 per cent. of water in this way, while the proportion is only about 2 to 3 per cent. in the case of coal of about the fineness of breeze, and falls to 1·5 per cent. when the size is that of No. 1 coke. (3) When handling considerable quantities, it is impracticable to dry by leaving the coal to drain; the time required being much too great. It was after ascertaining these facts that we arranged the top layer of coal in the way described above, with a view to observing the different behaviour of the three varieties in handling and in distillation.

The tank was emptied on April 17 at 5.30 p.m.; the water running off without incident, and without carrying any of the fine coal with it. The precaution was taken to fit the outlet-pipes with finely perforated covers, and moreover to surround the latter with fair-sized pieces of coal. About 4 a.m. next day the level of the water in the tank had fallen to zero; but the valves continued to deliver a considerable quantity of water derived from the draining of the coal. At this time the delivery from each outlet-pipe was about 30 litres (6½ gallons) per minute. After about fourteen hours, the water was escaping at the rate of about half-a-litre per minute.

On April 21—that is, 80 hours after starting to empty—20 metric tons of coal were removed from the top layer of the tank and from the section consisting of ordinary coal. Samples of the coal taken at this stage showed a proportion of adhering water of 9·8 per cent. The coal was carted and then delivered into the feed-hoppers of the overhead conveyors supplying the customary coal-store, one section of which had previously been completely emptied. The coal was thus treated exactly as when delivered from the wharf in the usual way. About midday the lot was all transferred to the feed-hopper of the stoking-machine. An analysis was again made, and the proportion of adhering water found to be 6·2 per cent. The loss of water in handling had thus been about 4 per cent. Although damp and containing fine coal, the material was handled without any special difficulty. It had a tendency to cake together; hence it was necessary to dig it out to some extent in the different hoppers, and place a man at several points along the series of tip-up conveyors, in order to ensure proper emptying. Commencing at 6 p.m., the coal was carbonized. It did not present any difficulty in the stoking-machines—one a De Brouwer and the other a Sautter; there being no noticeable jamming of the archimedean screw. The retorts were charged as usual.

### Tests with Screened and Large Coal.

This test having been made with coal as ordinarily supplied, it was evident that there would be no difficulty with the screened coal or with the coal in large pieces. Twenty-ton lots of these varieties of the same coal were treated in the same way on April 22 and 23 without incident beyond a certain tendency of the screened coal to "flow." From the estimations made of the adhering water, it was seen that during conveyance the screened coal lost 1·8 per cent. of water, starting with 6·8 and arriving with 5 per cent.; while in the case of the large coal the loss was 0·8 per cent.—the proportions before and after handling being 3·6 and 2·8 per cent. While remaining for six hours in the hoppers of the stoking-machines, the loss of adhering water in all three cases was extremely small. It was practically *nil* for the coal as supplied—0·4 per cent. for the screened, and 0·8 per cent. for the large coal. The difference is evidently due to the greater ease of evaporation the larger the pieces of the coal.

### Trial on a Full Working Scale.

On a conclusion of these tests, coal was removed in bulk from the lower part of the tank, and on April 25—that is, 7½ days after uncovering the coal—trial was made upon a full working scale. During the days of April 25 and 26, the full 420 tons were distilled; the coal being handled exactly as when delivered from the wharf in the usual way. At the commencement of operations it was found to have 8·8 per cent. of adhering water, of which it lost 3·8 per cent. before reaching the stoking-machines—a reduction which is practically in agreement with the previous tests. Lastly, on April 28, the content of moisture having decreased by further draining and evaporation to 6·2 per cent. in the tank, a lot of 120 tons was taken directly to the conveyors supplying the hoppers of the stoking-machines in order to reduce the cost of handling. The coal thus traversed an appreciably shorter route, and lost considerably less water. It was found to hold 5·2 per cent.—a loss of only 1 per cent.

The 600 tons of coal employed throughout the tests was treated in the retorts without occasioning any appreciable fall in the temperature of the furnaces. But the regular use of such coal would certainly lead to a reduced temperature of the furnaces, and necessitate either more powerful heating or else a smaller charge. Since the coal contains something like 6 per cent. of water, it means that for every 100 kilos. of coal about 6 kilos. of water have to be vaporized, needing about 4·5 per cent. increase in the heat units required. Either the furnaces must be caused to use a further 4·5 per cent. of fuel, or the charge in the retorts must be reduced. But the tests show that the handling of coal kept under water is effected without special difficulty beyond a delay of three to four days, and that when thus delivered to the retorts the coal is dry enough to be carbonized without inconvenience.

## THE PRINCIPAL SYSTEMS OF COKE-FURNACES.

As mentioned in the review of the proceedings at the congress of the Société Technique du Gaz which appears elsewhere, a long paper on the subject of the principal systems of coke-ovens was submitted by M. Berthelot. The following is an abstract of his communication.

The progress made in the coke-oven industry is a subject deserving of attention, since the economical advantages offered by closed furnaces cannot be ignored. The same remark applies to the use of the heat obtainable from the excess of gas from regenerative coke furnaces, a considerable number of which have been devised within recent years. The regenerator of the heat being the essential portion of a furnace of this kind, its design and construction exert a material effect on the stability and economy of the system—that is, on the time during which it can be kept in use, and on the quantity of gas available for different purposes. M. Berthelot proposes to classify furnaces upon a plan, more exact than that generally adopted, based on the regenerator.

(*a*) Recuperative furnace, Solvay system.
(*b*) Furnace with longitudinal regenerator in parallel, Otto, Collin, Piette, Carvès, Still, and Simplex systems.
(*c*) Furnace with longitudinal regenerators in series, Coppée system.
(*d*) Furnace with transverse regenerators in parallel, Koppers system.
(*e*) Furnace with transverse regenerators in series, Lecoq system.

*Recuperation of Heat.*—With the exception of Solvay, constructors have not adopted this plan, which has one-third the economy of the regenerator. Moreover, recuperation possesses the great drawback of leading to the re-passage of air in the flues.

*Longitudinal Regenerators in Parallel.*—In general, this system is more economical. If the regenerators are coupled together, there is re-passage of hot air in the flues; and if the latter are arranged upon the outside of the furnace, the loss of heat by radiation is considerable.

*Longitudinal Regenerators in Series.*—Since this arrangement

allows of the speed of movement of the air and of products of combustion in the regenerator being increased, the inventor thereby hopes to improve the efficiency of regeneration. The value of the coefficient of transmission of the heat being thus considerably greater, there is a slight advantage in consequence of the considerable re-passage of air in the flues, as a result of the great difference of pressure in the passages of the air and products of combustion respectively.

*Transverse Regenerator in Parallel.*—In this case no re-circulation can be produced; but the system affords an insufficient assurance of long continuous action, all the passages in superimposition having their axes parallel.

*Transverse Regenerator in Series.*—This system allows of the speed of circulation of gas and air being increased in the regenerators, and thus of attaining a higher value for the coefficient of transmission of heat.

*Regularity of Heating.*—Since this condition affects the quality of coke and the quantity of gas produced, it is of basic importance; for if there is unequal heating, it is difficult to obtain good coke in the less heated zones without over-heating the coal already acted upon. To put the matter in an extreme way, a good furnace should allow of making "cold coke"—that is, at a temperature of from 850° to 900° C. The regularity of heating depends on three conditions—namely, control of the gas, control of the air, and suitable design of the heating channels.

As regards the control of the gas, since 500 to 600 volumes of air are required per volume of gas, the adjustment of the gas requires to be more exact than that of air. This is secured in two ways—(1) by means of a retort of refractory material placed at the base and on the length of the pier; (2) by means of small pipes fitted with cocks, and placed under the structure or on the side of the furnace. Of this second method there are several variations. The retorts may be of diminishing section—a method which is open to criticism, since it is not possible to determine exactly in advance the loss of head which the current of gas experiences in each flue. Openings may be pierced in a movable retort—a system which is neither practical nor exact, for the operations are difficult and inconvenient, and the increase or reduction of the sections of flow is a matter of judgment. The other processes are exact; but it is extremely difficult to adjust the burners placed in a gallery which is under the furnace, in consequence of the high temperature. It is decidedly better to place the cocks on the side of the furnace.

For the adjustment of the air, the simplest process is to heat half of the structure. But it is easy to prove that the consumption of air between the first and the last flue is given by the ratio $\frac{Q_1}{Q_n} = e^{n-1}$. In order to obtain greater regularity, M. Koppers places registers at the upper part of the vertical (ascending) flues. M. Still uses retorts of diminishing section, which, once again, assumes a knowledge of the losses of head in each retort—scarcely possible in practice. An excellent solution of the problem appears to be that of M. Lecoq, who causes each section of air to traverse a course of equal length. Each flue thus receives the same quantity of air.

In the methods of heating the structure, there are appreciable differences in the several systems. According to some, half of the structure is heated; that is to say, that during each period of reversal the gas is admitted only to one half while the burnt gases descend by the vertical flues of the second half. Hence this method yields satisfactory results only when the adjustment of air and gas is not only possible but easy. Another system is alternate heating above and below, by which plan much greater uniformity of heating can be obtained; but this method is neither so correct in theory nor so favourable to the yield of bye-products. A third method is the heating by eight ascending flues followed by eight, three, or one descending flue. It is clear that this last plan should be the best; but, in order to prevent the descending gas from being heated by the ascending, adjoining flues require to be separated by brickwork of ample thickness.

In conclusion, it should be said that though M. Berthelot seemed to strike a somewhat pessimistic note as to the state of the coke-oven industry, he was careful to point out that considerable improvements had been made in the course of the last few years, and further researches promised excellent results in the future. It was, however, a good thing to inquire into what had been done, in order better to appreciate developments which might follow in due course.

The President and M. Godinet heartily congratulated the author upon his paper.

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The Council of the Royal Society of Arts have awarded silver medals to the readers of a number of papers during the session 1913-14; among them being Dr. William R. Ormandy, whose contribution on "Motor Fuels, with Special Reference to Alcohol" has been noticed in the "JOURNAL."

Arrangements have been made, by permission of the Otto-Oven Company, Limited, for the members of the Association to visit next Saturday the "Otto" bye-product coking and experimental plant at Crigglestone Collieries, near Wakefield. Probably an opportunity will be afforded the visitors of going down the pit.

## MEASUREMENT OF BRIGHTNESS.

This was the subject of a paper contributed to the American Illuminating Engineering Society by Dr. HERBERT E. IVES; and the text is given in No. 3 of the "Transactions" of the Society for the current year. The author emphasizes the importance of measuring surface brightness rather than illumination in cases where an adequate idea is to be rendered of the actual field of view of an observer. The following are the principal portions of the paper.

### INTRODUCTION.

In illuminating engineering, increased attention has of late been paid to the question of intrinsic brightness, not only the intrinsic brightness of light sources, but of all objects in the field of view. This is the logical outgrowth of a closer and closer study of the problems of lighting; for, in its last analysis, the task of lighting engineers is to produce in the field of view a distribution of brightness possessing certain desirable characteristics. The mere production of a certain illumination cannot guarantee a desirable brightness distribution, nor can a lighting installation be described, for purposes of scientific study, in terms of illumination.

A recent paper of the writer's before this Society,* in which measurements of surface brightness were used exclusively when describing the results of illumination experiments, brought out the fact that neither the meaning of such measurements nor the method of making them is as generally understood as should be the case. For this reason it seemed well to gather together in brief form some information on the subject.

### THE MOST STRIKING CHARACTERISTIC OF BRIGHTNESS.

Perhaps the most striking characteristic of brightness, as distinguished from illumination, is that it does not change with the distance between the bright surface (real or virtual) and the observer. A bright surface is equally bright whether one views it from 1, 10, or 50 metres. Brightness is a physical characteristic of the light-giving surface, not of the observer's eye or position. The meaning of this with respect to the eye is important. The light flux entering the eye from any small surface varies inversely as the square of the distance from the surface to the eye. But likewise the solid angle subtended by the surface varies inversely as the square of the distance. Consequently the flux per unit area of the image upon the retina remains the same—in other words, the brightness of the image is constant. The eye is a camera; and it follows immediately that a measurement of the brightness of surfaces in the field of view is also a measure of the relative brightness of the corresponding parts of the image on the retina. As a consequence of this attribute of brightness, it may be measured from any position. While, for instance, an ordinary photometer placed in the centre of a room can measure only the illumination at that point, a brightness-measuring instrument can, from this location, survey the whole visible room—walls, floor, and furniture. Perhaps the most accurate commonly understandable analogy to illumination and brightness measurements is furnished by the photographic camera. Let it first be used in the ordinary manner to take a picture of the room. This corresponds to the measurement of brightness. Let it then have its lens covered by an opal glass. Now all it can distinguish is the sum total of the light coming in a given direction. This corresponds to an illumination measurement. So illumination measurements may give a totally inadequate description of what the eye must endure.

### MEASUREMENT OF BRIGHTNESS.

The actual measurement of brightness is beset with practical difficulties, largely because the brightnesses met with in every-day lighting installations are of a range of magnitude quite beyond the capacity of any one instrument to measure. Thus the ratio of brightness of a tungsten filament to a white surface illuminated by 20 metre-candles is 258,000 : 1; while that between the filament and a shadow on black paper runs all the way up to a hundred millions. Practically three methods have been employed to measure brightness, depending on whether the brightness is high, medium, or low. As illustrations of what is meant by high brightness, we may take incandescent lamp filaments, in which the brightness or intrinsic brilliancy is of the order of magnitude of hundreds of candle power per square centimetre. As illustrations of medium brightness, take light sources surrounded by diffusing globes, such as opal glass, the intrinsic brilliancy of which may be about 0·25-candle power per square centimetre. As illustrations of low brightness, take the walls, or objects on the "working plane" of an ordinary room under a practical lighting installation, having brightnesses of 0·0005-candle power or less per square centimetre. The brightness of a lamp filament may be obtained by measuring the candle power of a known length of filament whose diameter is also known. The area is then the length times the diameter. A convenient way of making these high-brightness measurements is to determine, for one filament of the highest value obtainable, the value in the manner just discussed. at a known total candle power; determine the variation of candle power with some controllable variable, such as voltage; and then match the other filaments against this one by superposing them

* "Some Home Experiments in Illumination from Large Area Light Sources," given in the "JOURNAL" for Sept. 2, 1913 (p. 619).

upon its image. In this way values of all the ordinary light sources have been obtained and recorded.

The brightness of a diffusing globe is perhaps most easily ascertained by using a definite area as a light source and measuring with a photometer the resultant illumination at some convenient point. Usually the brightness is sufficient, so that the range of a common photometer will permit this to be done.

The brightness of a ceiling, wall, book page, table top, or floor is generally far too low to be handled by either of the above methods; and so in place of the glowing filament of high intrinsic brilliancy used for the first case considered, there is needed some low brightness surface of known value. The only surfaces with which such things as walls may be directly compared are those which, like walls, owe their brightness to illumination from a comparatively distant source of light. The fact that the illuminated surface in an ordinary photometer field is of this character makes it possible to modify a photometer used for illumination measurements into a brightness-measuring instrument.

The field of a photometer consists of two adjacent illuminated surfaces. The illumination of these surfaces is adjusted until they are equally bright; whereupon, by using the inverse square law or other expedient, and certain constants of transmission and reflection, the illumination at a point or the candle power of a source is calculated. Emphasis is here laid on the fact that really the operation is one of securing equal brightness. The actual value of the brightness of the photometer field is exactly measurable, and is not usually recorded, merely because it is a constant which drops out in illumination work. But supposing the usual diffusing plate upon which the illumination to be measured is incident be replaced by a darker or a lighter plate, then the brightness match obtained with the original plate no longer holds. A new setting is necessary; and from this may be calculated the reflecting or transmitting power of the new plate. But supposing the original plate, when illuminated in a definite manner, had been measured for brightness, then the scale of the instrument, instead of being divided and marked in terms of metre-candles, could, by the use of the proper constant, be calibrated in brightness or in candle power per square centimetre. Now when the darker or lighter plates are substituted, the brightness can be read from the scale. For these extra plates substitute the walls or the surface in question, as viewed through the photometer when the diffusing plate is removed. Then brightness may be obtained by operations exactly similar to ordinary photometry. Finally there will be obtained a constant which may be used to make a new scale on the instrument—the brightness scale. There will then be two: (1) The illumination scale (metre-candles) for use with the diffusing screen in place; and (2) the brightness scale (candles per square centimetre) for use without the diffusing screen.

The investigator or illuminating engineer furnished with a brightness-scale instrument carries out his measurements quite simply. He places himself at the point chosen as of most interest in the illuminated room, and points his instrument here and there like a spy-glass. In fact, if the surfaces he wishes to measure are so far away as to be ill-defined, he can use a lens to form an image in the focal plane of the eye-piece (which is the plane of the photometric field); thus actually making a "brightness-measuring telescope." He then selects the brightest spot, the darkest spot, the adjacent surfaces presenting the greatest ratio of brightness, &c. These having been obtained, the neatest way to record them is upon a photograph taken from the same point. The photograph is itself, if made through a proper colour screen, a map of brightness. But as usually made it possesses no attached scale; nor can any ordinary photographic plate begin to record proportionately the enormous brightness range which exists in most artificially lighted rooms.

Mention should here be made, too, of the fact that in measuring the brightness of walls and furniture the two halves of the photometric field are usually of different colour. As a consequence, the sensibility is lower than in ordinary illumination measurements, and the uncertainty greater. But, for the present at least, the accuracy demanded is not so high.

### Meaning and Character of Brightness Measurements.

The chief place of brightness measurements is in the description and analysis of lighting conditions. It must be remembered that what the eye sees is not illumination, but a distribution of brightness in the field of vision. The eye is a camera which reproduces upon the retina an exact picture of the outside world. Hence to know what the retina is receiving one must analyze exactly what the outside world is from the standpoint of brightness. Illumination, upon which most stress has been laid heretofore in measurement, must be looked upon merely as a means for producing the brightness distribution. Now, it is in the work of finding what arrangements of brightness in the visual field are safe or pleasant that the kind of measurements previously described are essential. Properly made, they constitute a complete map of what the eye sees.

A few illustrations will show more clearly what the distinction between illumination and brightness means. Take first, as the most extreme case, rooms with black and white walls. The walls may in each case receive the same illumination, but it is obvious that the retina does not receive the same stimulation by looking at the white and black surfaces. A measure of brightness, on the other hand, is a real index. Take now less obvious cases. Consider a room illuminated by overhead exposed light sources. Let the observer, without changing his position, place and remove an eye-shade. While the "working plane" illumination remains constant, his visual field is quite revolutionized from the standpoint of comfort. A plot of the brightness distribution in each case is again a true index of the physical cause of the different effect on the observer. A similar case is presented where overhead lights are raised several feet. The illumination may be lowered, but the visual field is freed from its most glaring features. Consider an observer facing a large-area moderately bright surface, such as a ground-glass window. Next let the window be replaced by a black surface in the centre of which is a point source of light of the same candle power as the whole white surface. Now, although the same amount of light enters the eye—*i.e.*, the illumination at the point where the eye is located is identical—the distribution of brightness is radically different, as is the visual effect from the standpoint of comfort. A practical illustration of this last case is to be seen in buildings where by day a skylight illuminates an area efficiently and pleasantly. At night sharp points of light against a dark background give an equivalent illumination; but, so far as brightness distribution is concerned, it is about as bad as possible.

It is not the purpose of this paper to discuss what constitutes good and what bad brightness distribution, but attention may be called to a recent admirable analysis of artificial and daylight conditions (by Mr. P. W. Cobb), in which it is shown that the extreme brightness ratio by daylight in a given instance between the brightest and the darkest visible areas was as 400: 1, while by artificial light they become as 100,000,000: 1. These figures are extremely suggestive; they are brightness and not illumination values.

As already remarked, brightness measurements give the only complete means of describing physically what the retina is receiving from a given lighting installation. They should therefore be used lavishly wherever questions of the relative advantage of different schemes of lighting are under discussion.

## MANUFACTURE OF ILLUMINATING GAS.

The Compagnie Française du Centre et du Midi pour l'Eclairage au Gaz have taken out a French patent [No. 466,197] for a process of manufacturing town gas by the fractional distillation of coal in a closed vessel; producing at first gas of high illuminating power, and subsequently gas of great calorific power, after catalysis. The following particulars of the process are translated from the specification, which has recently been published.

Distillation being carried on in a retort or chamber charged and discharged continuously or at intervals, the cold coal in contact with the hot sides first produces mainly the following hydrocarbons, which constitute the primary gas and are separately discharged:

$$C_6H_7 + C_7H_8 + C_{10}H_8, \&c.,$$

condensable vapours which are transformed in a suitable red-hot chamber into gaseous hydrocarbons, then

$$C_4H_4 + C_2H_4 + CH_4$$

and finally hydrogen and a certain proportion of carbon monoxide. This primary gas is brought up, when necessary, to the usual calorific power by admixture of water gas produced in a separate vessel, or in the retort or chamber by the introduction of steam.

The final gas is discharged through a different nozzle from that used for the primary gas. Each of these nozzles can be put in communication with a special exhauster, by regulating which the two gaseous currents can be separated in the retort or chamber. This gas consists chiefly of methane, hydrogen, and carbon monoxide. It is mixed with water gas produced as already stated, and in suitable proportions to be directly treated by catalysis, without previous decarbonation, and after simple purification by washing and separation of the sulphur. After catalysis over reduced nickel at a temperature of 300° C., a gas is obtained which contains more than 50 per cent. of methane. This gas can be brought up, if requisite, to the usual calorific power by the addition of water gas. Finally, the two gases can be mixed to form a saleable town gas having a lighting and heating power sufficiently good to meet the requirements of concessions.

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On Saturday, the 4th prox., the members of the North-Western District Division of the Institution of Municipal Engineers will visit the works of the Ashton-under-Lyne, Stalybridge, and Dukinfield District Joint Water Committee. The Engineer-in-Charge and Manager (Mr. F. J. Dixon, F.G.S., M.Inst.C.E.) will conduct the party over the works.

Professor Sir William Crookes, O.M., D.Sc., President of the Royal Society, received the hearty congratulations of his many friends and scientific colleagues on the celebration of the eighty-second anniversary of his birthday last Wednesday. At Burlington House the previous night, Sir William and Lady Crookes entertained a distinguished assembly; the occasion being the ladies' *conversazione* of the Royal Society. Professor Crookes, it may be remembered, was for some time associated with Sir James Dewar in the examination of the London Water Supply.

# WAVERLEY ASSOCIATION OF GAS MANAGERS.

### Annual Meeting in Edinburgh.

As recorded in the "JOURNAL" last week, the Ninety-Eighth General Meeting of the Waverley Association of Gas Managers was held on the 12th inst., in the Cathedral Hotel, Edinburgh, when a representative gathering of those connected with the gas profession was present. Mr. W. S. EASSON, the Engineer and Manager of the Jedburgh Gas Company, the President, occupied the chair.

The HON. SECRETARY (Mr. C. Hamilton, of Loanhead) having read the minutes of the previous meeting, which were approved,

The PRESIDENT delivered the following

## INAUGURAL ADDRESS.

Gentlemen,—To-day, on this, the ninety-eighth general meeting of the Waverley Association of Gas Managers, permit me, at the outset of my address, to acknowledge again the honour you conferred upon me in electing me President, and to thank you in all sincerity for this coveted and highly-esteemed honour. Some twelve years ago it was my privilege and pleasure to attend my first meeting with the Waverley members, under the presidency of Mr. Tulloch, at Loanhead. The meeting was marked throughout by enthusiasm and zeal; and the manner in which the subjects under review were discussed, and the record of difficulties overcome, made an indelible impression upon me. In filling the chair to-day, I am fully conscious of the responsibilities attached thereto. But for the early influences of my first visit to the Waverley Association, and the resolutions and inspirations then made and received, I should not be occupying this position now. To fulfil adequately the duties appertaining to the presidential chair is becoming year by year a task of greater severity.

To the manager of the small works the industry is indebted; and to-day I am sure we have the united goodwill and best wishes of those of our brethren who rank in the management of the larger concerns. We all acknowledge the value of these meetings, and I look forward to your united efforts to make this meeting a happy and beneficial one. In honouring me, you honour Jedburgh and the memory of my predecessor, Mr. George Taylor, who for so many years was a pioneer in the work of this Association, holding office both as President and Secretary.

Some years ago it was the custom of our Association to hold the meetings in the town over the works of which the President was manager. To-day we are forbidden this pleasure because of our altered constitution. This, to my mind, is unfortunate, as visitation means seeing, and seeing is believing, and one may get useful hints by viewing the various works. I am sure more can be said in favour of the old system of visitation than against it. Further, permit me to say my Directors were sorry at not having the privilege of extending a unanimous and hearty invitation to the members of the Association to spend the day in the old Border town.

### THE ASSOCIATION'S BEREAVEMENTS.

Since our last annual meeting, our Association has been bereft of three of its oldest members. Mr. Daniel Macfie, who for many years was associatted with that long-standing firm, so well known in our industry, James Milne and Son, and who latterly carried on a private business, died with startling suddenness, the news of which came as a shock to many in the profession. He was respected and held in high esteem by our members especially. His outstanding personality and commanding appearance, together with the ability he showed in grasping problems and solving them, made him a leader in our ranks. One felt that with his presence a meeting was sure to be successful, and in his periodical visits to our various works he never refrained from giving of his best, whenever his advice was sought for. To-day we shall assuredly miss him in the discussion. Mr. Black, of North Berwick, and Mr. Hamilton, of East Linton, were also for many years respected members. The falling-off of our older members impresses upon one the necessity of having their places filled, and reveals the importance of having younger members in active service.

### THE COMMERCIAL SECTION.

During the past twelve months, I am pleased to say, the Committee, according to the powers you vested in them at our last general meeting, drew up a scheme for a Commercial Section; and since January of this year members who were in favour of the conditions imposed, and considered necessary by the Committee for the satisfactory working of the scheme, have received, month by month, reports on stocks held and prices received by the various works for bye-products. Whether or not the venture is worth the trouble and cost remains with you to decide. We have had six months' experience now, and from that experience you can say whether you consider yourselves benefited or not.

Personally, I am much in favour of the scheme, as the reports show at a glance what stocks of bye-products there are in the district and the prices being received for them. This is extremely advantageous for those whose supplies of coke cannot meet the local demand, because others who have surplus stock are guided in fixing a price which will not be a means of cutting the local price. Holders of surplus stock are also made aware of the district where there is a scarcity, and prices can be better regulated. The scheme, if gone into thoroughly, and complied with by all in the industry, should actually be a means to a great end—that of showing exactly the probable quantities of coke required in the respective districts. With twelve months' experience we shall have data to go by. I quite agree that the coke market fluctuates considerably, and that a mild winter tells its own tale; but, in my opinion, this should weigh towards unity in the working of the scheme, as the larger producers of coke are in a position to regulate their surplus stock according to their coal, shale, or oil purchases. Further, the reports show at a glance what prices are being received for tar, liquor, and sulphate of ammonia, and those in outlying districts are kept well informed of what prices should be received for these bye-products. By paying attention to these reports there is not much chance of being undersold.

### MAINTAINING THE PROSPERITY OF THE GAS INDUSTRY.

To-day, we represent an industry which is still forging ahead. The gas consumption is increasing by leaps and bounds. To ensure a continuance of this prosperity is the problem set us. I wonder often what our real qualifications as gas managers should be, more especially the manager of the small works, on whose shoulders lie all the duties involved, from the selling of a mantle to the planning of a gasholder, or the fixing of a season's coal contract. We will appreciate and recognize the greater importance of these duties and the heavier responsibility they entail when we realize the confidence and trust vested in us by our employers, whether company or corporation. We have, however, to admit our limits; and who can blame us if we seek communion together at times, to discuss points of importance relative to our profession?

In times of dulness and slackness of business we are compelled to seek for new lines of expansion or increased income; and how can we better employ ourselves than in spending ourselves for others? "What's in must come out" was the saying in his quiet moments of a wealthy gentleman, who had previously lost his temper and said things better left unsaid. How true this seems when I look back some years, and recall the occasional visits of brethren in the gas fraternity under the parental roof, listening to the animated conversations, beginning with gas, continuing with gas, and ending with gas, until an outsider was inclined to think that we folks had "gas on the brain." To-day the need for both talk and action is greater than ever. Competition is becoming keener every day; and to meet it we must have cheap gas. In some of our smaller works, in outlying districts, where gas is comparatively high in price, we still have in the field of competition paraffin oil, along with petrol-air gas and electricity. Imagine the work laid out for the manager of the gas-works in such a locality, not so much in the way of preparing figures for comparison, but in endeavouring to convince people of the folly of their habits.

### COMPETITIVE ILLUMINANTS.

With gas at 4s. 5d. per 1000 cubic feet, the following relative values may be of interest to some of you. Paraffin oil, as is generally used by our average householder to-day, is bought at something like 9d. per gallon. It was found that with a duplex burner a gallon of oil would burn for 25 hours, yielding a light, roughly estimated, but keeping on the safe side, of 40-candle power. Working this out, we find the cost equal to almost three hours for 1d. Petrol-air gas to-day has increased considerably in cost as compared with what it was some five years ago—due, of course, to the increased cost of petrol and of labour. What you could purchase for 1s. 3d. then now costs 2s. 2d., and a good petrol oil having a specific gravity of ·650 (which is certainly the best for the purpose), even when mixed with a proportion of heavier density, will run to not less than 1s. 10d. per gallon. With a practical test, running a plant on the basis of 75 lights per hour, it was found that a gallon of petrol would burn for 123 hours, yielding a light calculated at 80-candle power. Working this out, we find the cost equal to 5·6 hours for 1d.

Electricity in small outlying districts is as expensive to-day as it was ten or twelve years ago. According to certain systems, you may pay 7d. per unit, with free wiring—*i.e.*, the house is fitted free, and you contract to use the current at 7d.—or pay for your fittings and the charge is 6d. a unit. A unit of electricity will give, assuming the efficiency to be 1 watt per candle, 12½ hours of an 80-candle power lamp. Working this out, we find the cost equal to two hours for 1d. Coal gas with a standard candle power of 18 will yield its corresponding value in heat units; and therefore we may safely rely on getting, with a good incandescent inverted burner, a return of 30-candle power per cubic foot. With gas at 4s. 5d. per 1000 we find one burner will yield 90-candle power at a cost of 1d. for seven hours.

Reducing these data to the common basis of an 80-candle power light, we have:

| | Hours' Light for One Penny. |
|---|---|
| Paraffin oil | 1½ |
| Petrol-air | 5½ |
| Electricity | 2 |
| Coal gas | 7⅞ |

### COMPETITORS IN THE FUEL FIELD.

Though these tests show our product to be the most economical, we still have great room for a reduction in price. In comparing notes with our competitors in the field of fuel, using gas as a heating agent, I found the following figures to stand examination and argument—being based on actual results, and verified by reference to certain people, all well known in the locality.

A room 15 feet square, and ceiling 9 feet high, was heated with coal in an ordinary room grate, such as is found in the average house of to-day. To raise the room temperature from a fixed degree, and maintain it at another degree for a space of fourteen hours, required a consumption of 40 lbs. of coal, which, at 1s. 3d. per cwt., worked out at approximately 0·38d. per hour. An anthracite stove designed to heat a room of the same dimensions was afterwards tried, and fitted-in just as we would fit-in a gas-fire, exposing no flue-piping, as is commonly done with these stoves. To bring the temperature of the room up in the given time required a considerable consumption of fuel. With the temperature once raised, its maintenance required 20 lbs. of anthracite, which, at 2s. per cwt., worked out at 0·30d. per hour. Using a gas-fire as designed to suit the same dimensions of room, and fitted-in so that conditions would be as nearly as possible in keeping with the previous stove, to bring the temperature of the room up to the required degree in the allotted time required 20 cubic feet of gas; and the consumption was afterwards adjusted so as to maintain the desired temperature for the same period of time. With gas at 4s. 5d. per 1000 cubic feet, the gas-fire worked out at an average cost of 0·5d. per hour.

I never have been an advocate of gas-fires for rooms where a sixteen-hour per day consumption is required, except, perhaps, in the nursery or sick-room, where cleanliness and convenience are two essentials, and steady temperature must be maintained. But as these figures show, and considering the many advantages gas has over these competitors, and with a reduced price for gas for heating, we might do worse than claim a right for all-day sitting-room gas-fires. The anthracite stove has certainly been well boomed for its 24 hours' consumption and duration; but I am not sure if we can accept all that is said in its favour. Assuredly we detest the 2 to 6 feet of 6-inch flue-piping that we see them fitted up with; and they are anything but bright, cheerful, or welcoming.

As already said, my figures will stand for practical purposes when combined with the many advantages gas can show over the use of other fuel and appliances. Nevertheless, we should not forget that a waiting public will take up our cause more wholeheartedly if we can but announce occasionally a reduction in price. A reduction in price means an increase in manufacture; and the problem set the gas manager of to-day is, "How can this best be done?" We can hardly expect great reductions in the price of coal, considering the demands of labour and other circumstances; but for small mercies, the prophet said, "Be thankful." A 6 per cent. reduction on the raw article is equivalent to 1½d. per 1000 cubic feet on the manufactured gas to us; and if we could only intimate annually a reduction of 1d. per 1000 cubic feet to our consumers, I am sure that our sales would be greatly increased.

### COALFIELD CONTROL.

Considering the great importance of coal to our industry, I have often wondered why some scheme has never been devised whereby we could have a certain amount of control over the coalfields. With the vast amount of wealth represented, and knowing how much companies and corporations alike are dependent on coal production, surely some safeguards should be made, and rights conserved, in the production of this very important raw material. Some six years ago, we in Jedburgh effected a considerable saving in our coal carriage bill by the purchase of some railway waggons. In the open market, one could purchase a 10 or 12 ton coal-waggon for £60 or £70. This waggon, with attention, could be made to run five times a month to and from a colliery, carrying an average of 60 tons. Working this out at the charge which is put on ordinary colliery or railway company's waggons—viz., a sum of 8d., or thereby, per ton of coal—we find our private waggon to bring in £2 per month, or £24 per annum. At this rate, the first cost of the waggon is wiped out in three years, while the waggon will run well for fifteen years, provided a little attention is given occasionally to the tightening of nuts, painting, tarring, &c. With sufficient waggons, one could always look forward to a reduction of 8d. per ton of coal on contract prices. Unfortunately railway regulations have somewhat altered this to-day, and traders are prohibited from purchasing waggons—no doubt due to the large number of railway companies' waggons which have been freed for use since demurrage charges have been made compulsory. But traders who have waggons would do well to keep them in repair; and perhaps at some future date they can be converted into larger waggons without demur by the railway authorities.

### CARBONIZING RESULTS.

It is said fortunes can be either made or lost in the carbonizing department. Yet if we are getting an average of 10,000 cubic feet of gas per ton of coal, with a reasonable luminosity, and with a fuel consumption corresponding with the figures of our neighbours, does it matter what system of settings or mode of firing we introduce? Retort renewals cost us something like 0·25d. per 1000 cubic feet of gas sold. With round retorts 15 inches diameter and 9 feet long, in beds of five to the setting, with two shallow fires heating on the direct-fired principle, we find our results are very favourable. Unfortunately, we are not in a position to instal regenerative settings, as the river, which is adjacent to our buildings, rises rapidly to our retort-house floor level in times of flooding. A system of semi-regenerator settings might be built-in; but, in my opinion, the extra benefits to be derived would not compensate for the outlay, and therefore we are compelled to make the most of what we have. The only difficulty we experience is in maintaining the temperature. This, however, can be fairly well done by using a good dry, round coal, charging 2 cwt. per retort, and running four-hour charges. I am sanguine of seeing the day (not very far distant) when the system of vertical retorts shall be introduced in smaller units to smaller works; and, in my opinion, the vertical retort carbonizing system is the only one whereby any pronounced reduction in carbonizing costs can be made.

### CONDENSING AND SCRUBBING.

The condensing and scrubbing plant of a works cannot be too well attended to. With a perfect system of gradual cooling, the lighter hydrocarbons are converted into permanent gases, and, in my opinion, assist in volatilizing the lighter oils which may have been deposited with the heavier hydrocarbons, thus enriching the permanence of the gas. To attain this end, I believe in the condensing main inside the retort-house. Here the temperature is above that of the atmosphere outside; and by carrying from the end of the hydraulic or foul main a mild-steel condenser running round the four walls of the retort-house, giving the pipe a gradual rise of 1 in 50, whereby all liquid deposited will gravitate slowly to the hydraulic or foul main, the process of gradual condensing is most effectively done. An injection of steam at certain points and at certain times will prove very beneficial in stirring up any adhering particles of tar or heavy oils, and in liberating any ammonia which might otherwise be confined by these deposits, to be taken out later in the scrubber-washers. I cannot emphasize too strongly the great necessity there is for a periodical steaming of all the plant, beginning with a mild injection at the hydraulic main, and allowing the exhauster to draw it gradually round the interior condenser, putting in a fresh supply from the inlet to the outside atmospheric condenser, passing through the exhauster main and bye-pass to the scrubber inlet, and from the scrubber outlet to the purifier inlet. With all accumulations of tar, there are, in my opinion, certain traces of ammonia; and these should be well washed out by mild steaming or flushing with water, as the ammonia is our greatest asset in the condensing and scrubbing plant. Mr. W. Wilson, in his Presidential Address at the Informal Meeting of Scottish Gas Managers in April, gave important information on the ammonia question; and, certainly, there is a great deal in it. Are we extracting all we ought to extract? It will pay to give more time and attention to this important question, as ammonia is one of our best bye-products for revenue, and by getting the most we can out of it, it will help us in our quest for cheap gas.

### PURIFICATION.

Purification costs to-day are greatly reduced when compared with what they were some years ago. I question very much if the last word has been said, even with the latest in oxide purification, as the day may not be far distant when we will have a continuous system of liquid purification. If ammonium compounds, together with sulphur and other impurities, can be extracted from the crude gas, whereby larger profits will accrue, then we should give every encouragement to those pioneers engaged in such research work.

To-day I wish to show, so far as my experience goes, the comparative costs of lime and oxide purification. Twelve months ago we ceased to purify our gas with lime, as the cost seemed to be very much higher than by oxide. An ordinary limestone gave the following analysis: Caustic lime, 76·35; carbonate of lime, 3·36; silicate of lime, 8·60; silicate of magnesia, 1·25; iron oxide and alumina, 4; organic matter, &c., 0·84; sand, 5·60. It cost 15s. per ton, and gave the following results: 20 cwt. of lime shell slaked with water to the required consistency weighed 35 cwt.; showing that the active shells had absorbed 75 per cent. of water. The quantity of gas purified by this lime was 200,000 cubic feet, with no washer or tar-extracting plant. The labour in preparing the lime and filling it into the purifier cost 4s. 9d. So the ton of lime shells used to purify 200,000 cubic feet of gas was 15s., and cartage 9d., *plus* labour 4s. 9d., equal 20s. 6d. The 35 cwt. slaked lime yielded, on emptying the purifier, close on 40 cwt. in the open, bringing in a return of 12s., or 6s. per ton. Deducting the 12s. income from 20s. 6d. expenditure, we had 8s. 6d. as the net cost of the purification of 200,000 cubic feet of gas, or 0·51d. per 1000 cubic feet.

Last June we filled four 8 ft. by 6 ft. by 4 ft. 6 in. purifiers with two tiers of natural bog ore about 18 inches deep in each box, or 38 cwt. of oxide in each purifier, at a cost of 26s. per ton. Taking the 20 cwt. of oxide as costing 26s., *plus* cartage 9d., *plus* labour 2s. 6d., our total cost was £1 9s. 3d. This quantity of material has purified to date 1,100,000 cubic feet of gas, with no labour; and so far we have had no occasion to interfere with the working. With an admission of 2·75 per cent. of air, we get every satisfaction; and provided back-pressure does not become too severe, I learn on good authority that this quantity will run well into another season without having to be revivified.

In considering the cost, we have an expenditure at present of 29s. 3d. for the purification of 1,100,000 cubic feet of gas, so far costing 0·32d. per 1000 cubic feet. But assuming we run this quantity for another year, still revivifying *in situ*, our cost should

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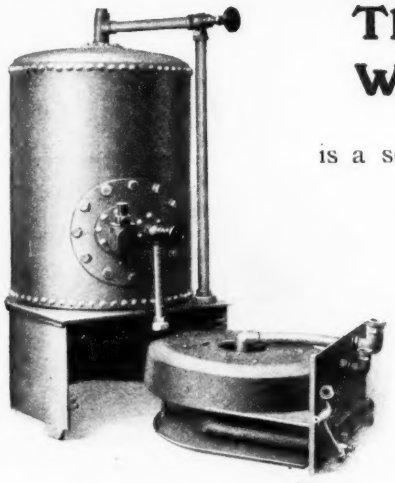

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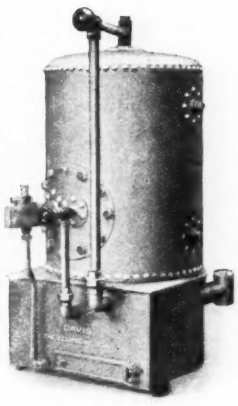
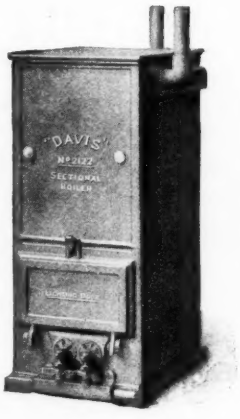
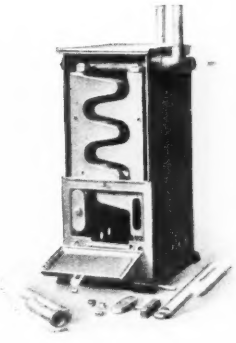





## The "Sectional" Circulator.

contains many improvements on this type of apparatus and is a model of efficiency and reliability. The heating elements are designed to occupy a minimum of space and yet provide an exceptionally long travel for the flue gases in contact with the heating surface.



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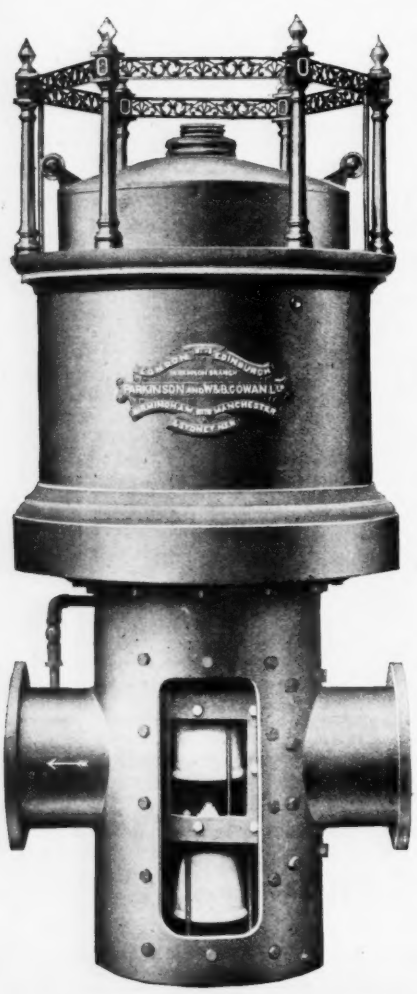

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be reduced to 0·16d. per 1000 feet. In working the oxide up to a marketable product, we require 60 per cent. of sulphur; and to attain this an extra sum of about 5s. for labour would be needed. For this we should then have purified 3,000,000 cubic feet of gas. Supposing, therefore, our first cost, *plus* 5s., should be taken, representing 34s. 3d., our purification cost would work out thus—34s. 3d., less value of 60 per cent. spent oxide, 20 cwt., now representing 32 cwt., for which we may receive 13s. 4d. per ton; or, 21s. 4d. taken from 34s. 3d. leaves 12s. 11d. as the net cost of purifying 3,000,000 cubic feet of gas, or 0·05d. per 1000 feet.

To-day we have purification by lime going on the same as with oxide—*i.e.*, with a percentage of air. From figures given me by a friend on the Borders, it would seem that lime might again displace oxide as a more economical purifying agent. In practical working, it is found that 20 cwt. of lime shells, slaked and filled into the purifier, cost, including labour, 20s., and that the quantity of gas purified, with 1½ per cent. of air, was 3,670,000 cubic feet; while on increasing the quantity of air to 3 per cent., the same quantity of lime purified 5,470,000 cubic feet. The cost on the above basis works out at 20s., less 8s. received for spent lime, equalling 12s. as the net cost of gas purified, representing 0·026d. per 1000 feet.

According to this statement, one realizes lime as the cheaper agent when worked with air. No doubt some who, as yet, have not tried oxide and are contemplating a change would do well to prove the results for themselves with 2½ per cent. of air. In my opinion 2·75 per cent. of air is efficient for revivifying *in situ*, as 3 per cent. in oxide shows quite visibly to the eye a deteriorating effect on the luminosity and from 3½ to 4 per cent. will "bring the town on your top." Further, why should we use an excessive quantity of air, when we realize the great amount of damage we may do to station-meter and holder interiors? Purifier covers alone will almost give an indication whether too much air is being used. Further, we must remember that with so low-grade a gas as is now being made we cannot afford to come much lower, or we shall soon be within the danger zone of explosive mixtures.

At this point I would remind you that naked lights should be exposed as little as possible in such places as exhauster and other plant houses. Concealed and safety lights are cheap and good.

### SULPHATE MANUFACTURE.

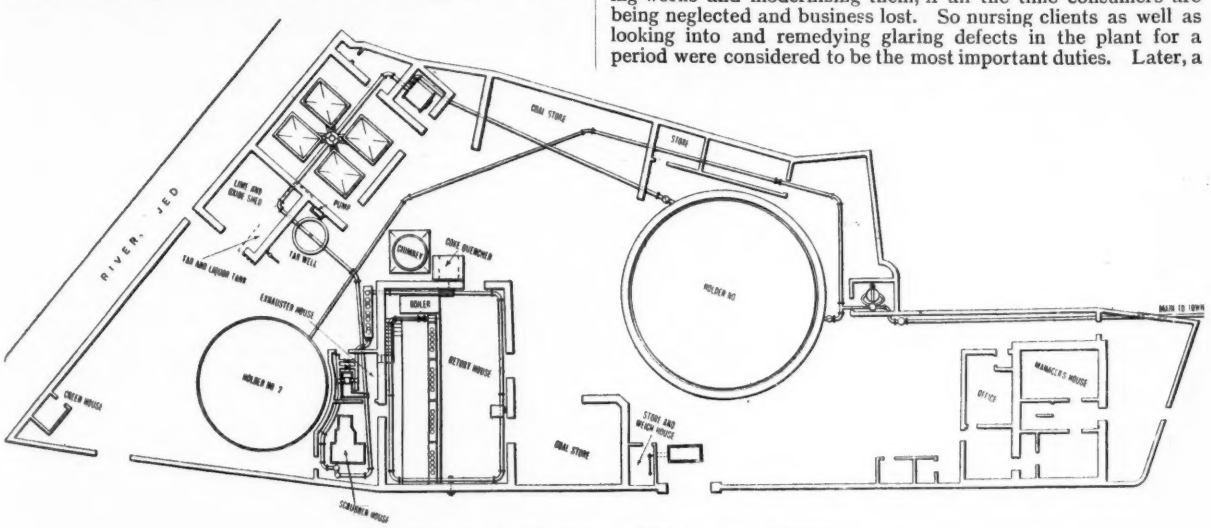
Sometimes the question is asked, Is it profitable for a works of such-and-such a make to lay down plant for the manufacture of sulphate of ammonia? In my opinion, a great deals depends on local and other circumstances, and what prices are, and can be, received by producers for the raw material. When we refer to what we might receive, as shown by Dr. Davidson in his lecture last September to the North British Association of Gas Managers, ammonia gas liquor of 10 oz. is represented as yielding £46 and ratio as 1, and sulphate of ammonia is represented as yielding £71 and ratio as 1·56. Surely the question is of importance. A works making 10,000,000 cubic feet of gas per annum, assuming it is getting 10,000 cubic feet of gas per ton, will use 1000 tons of coal. Taking 28 lbs. as a fair average for a ton to yield in the form of sulphate, gives 12½ tons, which, at the price of £12 per ton, net and naked, shows a return of £150. Deducting interest, depreciation on plant, expenses of fuel, acid, liming, and wages, we could, with safety, rely on receiving at least 50 per cent. as a clear profit on the working of the plant—£75. Further, crude coal tar freed from liquor will realize about 15s. per 100 gallons; and assuming we get 12 gallons per ton of coal, our 1000 tons will yield 12,000 gallons, which at 15s. per 100 gallons, will represent £90. So that for these bye-products we could quite safely rely on receiving £165.

Comparison of these figures with what we are actually receiving should determine whether or not the venture is worth it. For such a small plant, the first cost would be heavy; and to work it economically would require laying down storage tanks for liquor—all necessitating extra cost, which would tend to reduce actual profits. I should think no works with a make of less than 20,000,000 cubic feet could expect to reap much benefit nowadays, as competition compels distillers to tender more reasonable figures for the raw material. A works not far from here, making 30,000,000 cubic feet of gas per annum, was offered such a high price for the combined tar and liquor that, in my opinion, the question of sulphate manufacture was put beyond consideration. Certainly it will pay the distillers to offer very much better terms, even though their net profit should be only 5 per cent. At this time of the year, when prices are being received for bye-products, the monthly reports issued by the Commercial Section should be a help in deciding tenders.

### THE JEDBURGH GAS-WORKS.

Appended I bring to your notice a bird's-eye view of our works at Jedburgh; and perhaps you will pardon me if I say a few words relative thereto. Knowing we could not have a visit to the works, I thought you might appreciate my effort in trying to bring them to you. Some six years ago, in taking up duty at Jedburgh, I entered a model little works—retort-house, purifier, and meter-house, and lime-house all built of the very best material, and of good workmanship and design—a great credit to my predecessor. Unfortunately, the interior plant, so far as modern requirements were concerned, was antiquated and quite unequal to economical production; and with electrical and other competitors waging war, the battle looked like being a fierce one.

Though recognizing the great importance of having a fully-equipped and modern plant for manufacture, I regard very much more the importance of having an outlet for our manufacture. There is no sense in spending time and money on beautifying works and modernizing them, if all the time consumers are being neglected and business lost. So nursing clients as well as looking into and remedying glaring defects in the plant for a period were considered to be the most important duties. Later, a scheme for improving the plant was prepared and gradually carried out.




GROUND PLAN OF THE JEDBURGH GAS-WORKS.

Beginning with the retort-house, I found little alteration could be made on the carbonizing plant; there being four settings of five retorts in each oven, and two shallow fires feeding directly on each. The retorts are round, measuring 15 inches diameter by 9 feet long. With twenty retorts in all, we have ample carbonizing power for a considerable time to come; and, as already stated, to alter the somewhat antiquated method of firing would be extremely costly in our circumstances, and would serve no profitable purpose, as we get fairly good results. An Irving tar and liquor seal regulating valve and special casting was fitted to the end of the hydraulic main. This gave immediate control over the seal regulation on the dips, and also power to flush out the main periodically. From the valve we carried a 9-inch mild steel foul main or condenser to the back wall of the retort-house, continuing it round the four walls, suspended from the roof girders with steel straps and loops and resting on brackets and roller cradles built in each gable, rising 1 in 50; so that all condensation gravitates back to the Irving valve. A Cornish boiler, 12 ft. by 4 ft. 6 in., is conveniently built-in, in line with the retort-benches, giving 30 lbs. steam easily maintained with coke breeze as fuel, and adequately supplying our needs for three small engines. The condensers are of ordinary atmospheric type, with all necessary connections fitted for steaming and flushing.

The exhauster-house adjoins the condensers, and contains one of Bryan Donkin's two-blade exhausters, with their hydraulic main regulators to govern the speed of the engine. The exhauster is capable of passing 5000 cubic feet of gas per hour. A 1-inch mild-iron pipe is carried from the regulator to the hydraulic main; and by this means the exhauster is well controlled. A through-way door leads to the washer-scrubber house, where we have erected one of Creek's patent scrubber-washers, with Livesey tar-extractor combined; the latter serving as a base for the over-

head drums and brushes. A small 1½-H.P. engine drives these brushes with ease, through suitable gearing; the whole work of scrubbing being done very effectively.

Over the exhauster-house we fitted up a bath-room for the men, conveniently entered by a stair leading from the retort-house. Concealed borrowed lights are used to illuminate these houses, and are built into the retort-house wall. Believing prevention to be better than cure, I in no way encourage the use of naked lights in any part of the works, except the retort-house. There are four purifiers, each measuring 8 ft. by 6 ft. by 4 ft. 6 in. deep, worked with a centre-valve; three purifiers working, and one always off. Oxide is the material used; and by admitting 2·75 per cent. of air, and turning the valve every 24 hours, forward rotation, our purification goes on effectively and without trouble.

The station-meter is the ordinary cylindrical one of Messrs. James Milne and Son, Limited, to pass 5000 cubic feet per hour. Attached to the main spindle of the meter we have a spur-wheel fitted, working into a roller-chain (the same as a bicycle wheel and chain), which in turn revolves a similar wheel fitted on to a small spindle in an overhead cylindrical vessel. A worm or coil is fixed to this spindle, and revolves with the motion of the station-meter. As the vessel is filled to a certain level with a light oil, air is drawn in at the open end of the worm immediately it emerges from the liquid, and is sealed in the worm by the further rotation of the spindle, and liberated into a pipe leading to a small meter, where it is measured and sent forward to the condenser inlet. This little apparatus gives a supply of air only when needed—*i.e.*, when the station-meter is measuring gas—and can be regulated to give any quantity. With its use, the gas manager can retire with a fairly easy mind, as readings can be taken at any time by any of the workmen on duty.

All pipes are laid with a gradient leading to the tar-well, from which all tar and liquor is pumped by a small engine to an overhead storage tank. A car-tank of 250 gallons capacity conveys all the tar and liquor to the station, where it is emptied into a railway tank-waggon. We experienced considerable difficulty in getting a loading bank on the railway company's premises; but by persistent pressing we managed to secure one on reasonable terms.

Our holders are two in number, and represent 60 per cent. of our 24-hours' maximum make. Although on the small side, we experience little difficulty in maintaining a good and efficient supply, having ample reserve in retort power.

In distribution, we believe in good pressure, even though there be faulty mains. As cheaper gas means increased consumption, old and small services cannot give the required quantity, except with increased pressure. No doubt unaccounted-for gas or leakage would be greater; but with a system of main renewals whereby old mains are replaced and defective ones overhauled, profits and satisfaction are increased in the end. During the last four years, we have systematically renewed part of our old mains, replacing them with steel. Much can be said in favour of the steel main over the cast iron; but I am inclined to think trouble will dog those who are not very careful with the outside wrapping. After transit, we often receive the pipes scratched on the outside; and when exposed for a short time in the open, you can notice pitted corrosion beginning. Moreover, with the passing of excessive air through our purifiers and holders, we may be sure of trouble in the steel main interior. I admit the mains are coated in the interior with a special solution; but unfortunately, in my opinion, this solution is affected by the action of our low-grade gas, and becomes quite liquefied and gravitates back to the drips.

Every consideration is given to the consumer by enlarging services and giving new meters free. Gas formerly sold at 5s. 10d. per 1000 cubic feet is now selling at 4s. 5d., and slot consumers pay a sum of 3s. per annum for meter-rent. This latter charge is made indirectly through the slot; and if the meter does not yield this sum at the close of the year, we do not press for payment.

Cookers are let out on simple hire at the very lowest rates consistent with a profit, and all are fitted free. From experience, I think it will pay companies to abolish rents on cookers altogether and give them rent free. Why charge 1s. a quarter, if we find the charge acting as a deterrent? According to our rules, a client leaves an order for a cooker to be fitted-in, and the average cost amounts to 15s. According to the agreement, they have the power to order the removal of the cooker at the end of twelve months; and often we are compelled to obey the order. We cannot disconnect, remove to works, and clean it up for anything less than 6s.; and if we add the two costs, less the sum received for hire, our expenditure stands at 17s. Now, it takes a considerable consumption of gas to give a return on such an outlay; and when the actual facts are worked out, it is found we are heavy losers. When the cooker is out on the free system, with no obligation on the part of the consumer, we find the cooker may "sit" permanently; and if there is no immediate need for its use, we may suggest the throwing of a cover over it to keep it clean and free from dust, knowing that in some unprovided-for moment, when fires will not burn, and other domestic troubles assail the good lady, the cooker will meet the emergency, much to her satisfaction and surprise. This usually ends in continued service. Gas-fires and other appliances are fitted free; and anything with a tendency to encourage consumers in a larger and freer use of gas is done.

### ELECTRICITY SUPPLY.

In concluding, allow me just to mention the pressing necessity there is for gas managers, in towns where as yet there is no rival electrical company, to consider the question of electricity supply. We are living in a demanding age. Novelty by some and necessity by others, must, and will, be met; and we find both in abundance. There is a class of people who consider expense no object, provided their whims and petty wants are supplied. Gas companies are in the very best position to supply these wants. From the vast experience obtained from well-nigh a century spent in catering for, and giving satisfaction to, the public at large, they can both generate and distribute any required energy on the most economical lines. Moreover, where one central body governs both undertakings my experience leads me to say that greater satisfaction is received by consumers.

### DISCUSSION.

Mr. A. Masterton (Edinburgh) said he had listened with pleasure to the extremely interesting address of the President. They had greatly benefited by it, and he was sure had gained considerable information. He observed that the present was the ninety-eighth general meeting of the Association, and they would therefore soon be celebrating its centenary. He hoped something of an outstanding nature would be arranged for on that auspicious occasion. The President had gone very fully into the comparative values of paraffin oil, petrol-air gas, electricity, and coal gas; and they owed him their best appreciation for having so clearly enunciated the subject by an able process of reasoning, which would prove most helpful to managers, who were so often called upon to show comparative costs. He was sure they were all in sympathy with his remarks on the importance of coal to the gas industry. He considered deserving of careful attention the President's reference to the purchase of waggons, as it was a means of getting reduced expenses, especially where the company had the necessary capital available. Then again Mr. Easson had suggested that gas companies should consider the question of the supply of electricity. The suggestion was an excellent one, as it would prevent waste of capital in each department. He considered that every gas company should have a modern and properly fitted-up show-room, equipped with all the latest appliances; and, as far as possible, they should be coupled-up with the gas and water supply for demonstration purposes, so as to be shown under working conditions.

Mr. D. Vass (Perth), referring to the President's suggestions in regard to the purchase of coal-waggons, said the Corporation of Perth had hired waggons for a number of years, and they found that, on the whole, they paid; but of late there had been a falling-off. Taking it all in all, the hiring of waggons paid; and if hiring paid, purchase would pay much better. Anyone who had the opportunity of securing a supply of waggons would find it a profitable investment, not only from the point of view of finance, but also of delivery of the coal. He was pleased to see the position Mr. Easson had taken up with regard to gas-cookers on the question of free installation, though the Perth Corporation had recently taken a backward step. They had been supplying these free, but had decided to revert to a charge.

Mr. H. O'Connor (Edinburgh), on being called upon to offer some remarks, said he should like to add his congratulations to the President on the excellence of his address. One point to which he wished to refer specially was the comparative prices he had mentioned in connection with the different illuminants. He thought the President had been rather too kind in the case of petrol-air gas. From his own experience, he did not think they could get more than about four hours' light, of the quality Mr. Easson gave, for 1d. The spirit commonly used—·680 spirit—was capable of giving, for a gallon, 134,000 heat units; and this was one of the principal ways of comparing it with coal gas. After all, it was for the heating of the incandescent mantle that the petrol or coal gas was used. Generally speaking, with gas of the quality that was being usually supplied, they might take it that they required to use four times the quantity of petrol gas compared with coal gas. He noticed the remarks of the President regarding an anthracite stove. There was one point about this stove that came home straight to him. It was all convected heat; there was practically no radiated heat. It did not remove from the room the foul air of the occupants, and unquestionably it was not a ventilator, such as a gas-fire was and should be. An anthracite stove was not a healthy one to put into rooms; and the more often they could mention this, the better they could do for their own productions.

Mr. J. Hepworth (Edinburgh) said he agreed, first of all, with what the President had said about competition becoming keener every day, and that they must have cheaper gas. They could cheapen gas in many ways; and Mr. Easson had pointed out methods that were most important. With regard to the President's remarks on vertical retorts in smaller units for smaller works, he thought such retorts were coming. He believed they were doing admirably. He had every confidence in them, as a means of substantially reducing carbonizing costs.

Mr. J. Richmond (Penicuik) expressed the belief that the more they could decrease the cost of gas the more business they could get. He would like to have a little more information regarding the figures the President had given as to lime purification. He had used lime himself, and had obtained good prices for his spent material. No remarks had been made with respect to what the President had said about gas-cookers, except that it was very desirable to let them out free. A trouble which he had experienced was that a great many of their smaller consumers refused to instal them for want of convenient accommodation. It would, he

thought, be a good thing if, in small houses, a recess were made beside the kitchen range.

After some further remarks, the discussion closed.

### The Accounts.

The President read the balance-sheet for the year to May last. It showed that the income of the Association amounted to £37 9s. 3d., and the expenditure to £20 7s. 1d.; leaving £17 2s. 2d. in the hands of the Treasurer, compared with £15 14s. 9d. for the previous year.

On the motion of Mr. Black, seconded by Mr. M'Ewan, the balance-sheet was adopted.

### Election of Office-Bearers.

The following were appointed office-bearers for the ensuing year:

*President.*—Mr. Cuthbert Hamilton, of Loanhead.
*Hon. Secretary.*—Mr. R. W. Cowie, of Dalkeith.
*Members of Committee.*—Mr. J. D. Keillor, of Hawick; Mr. P. R. Chalmers, of Kelso; Mr. P. Blair, of Haddington; and Mr. J. Gemmell, of Melrose.

### The President's Medal.

Mr. Black then performed the ceremony of presenting Mr. Easson with the President's Medal; and the business concluded.

### Dinner and Visit to Granton.

The company subsequently assembled at dinner, after which a visit was paid to the Granton Gas-Works.

## STOCKPORT CORPORATION WATER-WORKS.

At the recent Annual Meeting of the Institution of Water Engineers at Stockport, the following description of the water-works was submitted by the President, Mr. T. Molyneux, Assoc.M.Inst. C.E., the Water Engineer to the Corporation.

The water supply to the borough of Stockport and adjacent districts was first undertaken in the year 1825 by a local landed proprietor and millowner, Mr. Peter Marsland, who obtained an Act of Parliament authorizing him to pump water from the River Goyt, which flowed along the boundary of his estate, and which provided power for his mills. The water was pumped, by means of a water-wheel, into a reservoir on his estate at Woodbank, and was then supplied through open sand filters to the district. This reservoir is still in use as a service reservoir; but the sand filters are dismantled, being no longer needed. In the year 1850 the undertaking was converted into a joint-stock company; the first Chairman being Mr. Henry Marsland, a son of the founder.

The River Etherow, on which the Manchester Corporation works are situated, is a tributary of the River Goyt, and when, in 1859, the Manchester Corporation obtained powers to reduce the amount of compensation water to the river, an agreement was made with the Stockport Water-Works Company by which the Corporation undertook to supply the Company with a million gallons of water per day at the price of 2¼d. per 1000 gallons.

In the year 1861 a Company, formed in opposition to Mr. Marsland's Company, obtained an Act of Parliament to construct reservoirs in Lyme Park, Disley; but after two years' antagonistic working, the two Companies amalgamated into one concern, which, by an Act of Parliament obtained in the year 1864, became the water authority of the borough of Stockport and surrounding districts—an area of about 71 square miles. In 1863 the Company ceased to take water from the River Mersey, and commenced to take it from the Corporation of Manchester under the agreement of 1859.

In 1867 the Stockport Corporation obtained an Act of Parliament authorizing the purchase of the undertaking; but the option was not exercised, and it was not until another purchase Act was obtained, in the year 1899, that the Corporation acquired the control of the undertaking. Almost immediately after the Corporation had purchased, it was found necessary to provide a further supply of water to meet the increasing demands of the district; and in 1901 an Act was obtained authorizing the construction of the Kinder works which have been recently completed.

### The Sources of Supply.

Before describing these works, it will be convenient to briefly describe the other sources of supply. These comprise (1) a supply from the Manchester Corporation, (2) the Lyme Park gathering-ground, and (3) the Wilmslow borings. The Manchester Corporation supply from their Longdendale works a maximum of 1,400,000 gallons per day through meters at Denton, and 100,000 gallons per day through meters at Haughton Green, in such quantities as are ordered three months in advance. The Lyme Park gathering-ground is about 1400 acres in extent, and feeds two reservoirs—"Horse Coppice," with a capacity of 73 million gallons (T.W.L. 666 O.D.), constructed in 1863, and "Bollinhurst" with a capacity of 84 million gallons (T.W.L. 730 O.D.), constructed in 1872. The outlet, in the case of the Horse Coppice reservoir, is carried through the heart of the embankment—a practice which is now abandoned, not only on account of the unnecessary risk it involves, but also because of the difficulty of maintaining the outlet-valves in a satisfactory condition. No compensation water is delivered from these reservoirs, as payments, amounting to £66,000, were made to the riparian owners under section 12 of the Water-Works Clauses Act, 1847, on the construction of the works. The rainfall averages about 33 inches per annum, and the minimum yield of the gathering-ground has been found to be 1,300,000 gallons per day, the whole of which is available for supply.

The water is conveyed for a distance of two miles by two mains, 15 and 12 inches diameter respectively, to High Lane, where there are three sand filters with a combined area of 1·8 acres, any two of which are capable of filtering at least 2½ million gallons per day—the maximum hourly flow being about 90,000 gallons. Two of these filters were originally made with sloping slides 1½ to 1; but in 1900 these were replaced by vertical walls, which increased the filtration area by nearly 40 per cent. The water passes from the filters into a small balancing tank at 450 Ordnance datum, and thence to the town through a 12-inch and a 15-inch main.

The borough of Stockport and the surrounding districts are situated on the outcrop of the New Red Sandstone, from which many of the factories obtain a supply for use in different trades, such as hatting, brewing, &c. This outcrop extends south from Stockport to the Cheshire Plain, but within a distance of 15 miles the water is saline, and within a distance of three miles to the south-east it abuts on the coal measures, from which it is separated by the well-known "Cheshire" fault.

At the Corporation works at Wilmslow the sandstone is estimated to be at least 800 feet thick. The three boreholes sunk at this works are all within a radius of 40 feet. The oldest, constructed by the Company in the year 1866, is 450 feet deep, and yields a bright, pure water of 14° of hardness. The second, constructed in the year 1894, was carried to a depth of 602 feet, and yielded water of 17° of hardness, but containing iron in solution, which oxidized on exposure to the air. Filling up the lower 152 feet of this boring with cement did not overcome the difficulty. The third boring, carried out in the year 1912, is 18 inches in diameter, and extends to a depth of 700 feet. Preliminary tests show that the water has only 12° of hardness, and does not contain any iron in solution. The hardness is entirely temporary, and can be readily removed by treatment with burnt lime; the presence of a small proportion of sodium carbonate accounting for the absence of any permanent hardness. The water contains only a very small quantity of organic matter of either animal or vegetable origin. It contains the merest trace of nitrates, and a somewhat larger, but still small, amount of nitrites.

These works are not at present in use; but previous to the year 1912 the supply was obtained from the first boring, which is 450 feet deep, by an air-lift plant operated by a 15 H.P. compressor; and also from the second boring by a pump suspended at a depth of 120 feet, driven from a 50 H.P. compound horizontal steam-engine; a total quantity of a million gallons per day being obtained from them. Some difficulty was met with in connection with the gearing of the pump in the second borehole, but it may be interesting to record the fact that this was entirely overcome by the use of machine-cut double-helical gear-wheels.

The water from this pumping-station was delivered into a cast-iron tank of 30,000 gallons capacity, and was then softened by the Archbutt-Deeley process. From the softening plant the water passed into an underground tank, whence it was pumped, by means of a tandem compound differential ram-pump of 60 H.P. and two smaller pumps of somewhat similar type of 30 H.P. each, under a pressure of about 200 lbs. per square inch, into a small balancing-tank of 250,000 gallons capacity situated on Alderley Edge, in close proximity to that now in course of construction.

When it becomes necessary again to utilize these works, it is intended to remodel them, by fitting up the new borehole with plant to lift a million gallons of water per day, deepening the larger of the other two boreholes, and lowering the pump-bucket, also by enlarging the softening plant, so that a duplicate supply of a million gallons per day will be available from this source.

### The Kinder Gathering-Ground and Reservoir.

This gathering-ground is 2100 acres in extent, and is situated on the flank of "Kinder Scout"—the highest peak in Derbyshire. It is drained by one of the tributaries of the River Mersey, which flows through the borough of Stockport. The average rainfall is 42 inches per annum, and the works are designed to utilize a supply of 3 million gallons per day—2 millions for supply and 1 million for compensation.

The two adjoining watersheds of Sett and Hollingworth Clough are included in the completed scheme of supply from this district; but it is not anticipated that further works will be required for many years. Meanwhile rain-gauge records are being kept in the whole area, and the flows of the various streams are being recorded by automatic gauges.

The construction of the Kinder reservoir was commenced in the year 1903; the dam being designed in masonry, curved in plan and 116 feet high, with open sand filters at the foot. The contract was let and the work proceeded until a portion of the concrete tongue trench and three sections of the concrete foundation of the dam were placed in position. At this juncture a dispute arose with the contractor as to the amount of excavation necessary for the foundation of the dam, for the stability of which he was, he

maintained, responsible under his contract. Then an action was brought by him against the Corporation, and as a result he obtained £48,332 as damages for breach of contract and in settlement of other matters in dispute.

The Corporation then reconsidered the whole question, and it was decided, after obtaining the best engineering advice, to abandon the masonry dam, and build an earthen embankment. The construction of this was commenced in the year 1907; the work already done being incorporated as far as possible. This accounts for the embankment being curved in plan. Messrs. G. H. Hill and Sons, of Manchester and London, were appointed as Consulting Engineers, and the work was done by administration; Mr. Basil Mackenzie (who had carried out work under similar circumstances for the Swansea Corporation) being appointed Manager for the Corporation.

The time allowed for the construction expired in August, 1911, and as four years had been lost owing to the trouble with the contractor, a special effort was made to have the reservoir ready for the reception of water by that time, though, as a matter of fact, owing to the year proving exceptionally dry, no water was available for impounding for some weeks afterwards.

In the meantime, the district being in straits for water, application was made to Parliament in the year 1905 for permission to obtain water from the river during the construction of the works. This power was granted on condition that no water was to be abstracted unless the quantity flowing down the stream was equal to 2 million gallons per day, and that the power should expire at the end of the period allowed for the construction of the reservoir.

An intake weir was at once commenced (clear of the site of the proposed works), and a pipe-line 27 inches diameter was laid from this to Disley, six miles nearer Stockport; this being the pipe designed for the permanent supply. At Disley a 21-inch branch pipe was laid to the Lyme Park reservoirs, and in June, 1907, the water direct from the river was first passed into the Bollinhurst reservoir, and thence, with the yield of the Lyme Park gathering-ground, to the sand filters at High Lane. This main is provided with two automatic throttle-valves and two back-pressure valves, which proved of great utility on three occasions when the main has burst. The filters at High Lane were also enlarged to deal with the joint supplies from the Kinder and Lyme Park gathering-grounds.

The only part of the contractor's work utilized in the altered design of the Kinder dam was the tongue trench, which had been partially excavated and a portion filled in with concrete. Where the concrete foundations had been formed for the masonry dam they were cut through to the top of the tongue trench so that the whole of the tongue should be continuous and uniform. The tongue trench is, in places, carried down to a depth of 184 feet below the river level.

The strata exposed were alternating grits and shales of the Yoredale formation; the beds being of varying thickness and greatly disturbed. An arm trench runs from the northern end of the embankment for a distance of 190 yards along the reservoir side, and was carried down 180 feet below the surface. At regular intervals along this trench wrought-iron tubes were built in the concrete, for use in case a further grouting of the rocks below the trench was found necessary. Fortunately, however, no grouting has been required. The material for the bank was excavated from inside the reservoir, so that the capacity was not reduced by the substitution of an earthen embankment for a masonry dam. The reservoir, as at first constructed, had a capacity of 503 million gallons; but finally a cast-iron plate a foot high, with a gun-metal edge, was let into the stone sill, which raised the capacity to 515,460,000 gallons.

### Filtration Plant.

On further considering the design of the filters, it was decided to instal mechanical filters, as the upper portion of the gathering-ground is covered with a peaty deposit which at times affects the water considerably.

The filter-house is 180 feet long by 39 ft. 6 in. wide, with a two storeyed annexe 39 ft. 6 in. by 35 ft. 6 in., and contains three batteries of filters capable of filtering 3,750,000 gallons of water per day; but the house is constructed to hold a fourth battery, in order to deal with the additional supply for which parliamentary powers have been obtained. Each battery consists of eight steel drums, each being 8 feet diameter by 4 feet high, charged with Leighton Buzzard sand, and capable of filtering about 150,000 gallons per day.

The water is delivered (by gravitation from the reservoir) into the top of the drums, and as it enters the filters it operates a series of motors which pump a standard aluminoferric solution in prescribed quantities into the raw water at the filter inlet. These motors are adjustable so that the quantity of the coagulant can be varied. The solution is dissolved in six rectangular tanks in the upper storey of the annexe. From these tanks it gravitates through a ball-valve into a small cistern fixed in the main building, from which it is drawn by the motor-driven pumps. Lime, as lime water, is also added to the water in proportions regulated by Venturi tubes as required, and measured by a manometer. The lime, which, as purchased, is guaranteed to contain 98 per cent. of calcium oxide, is first slaked, and then placed in four cylindrical drums 6 feet in diameter by 20 feet high, one for each battery and one to spare. Water, passed upwards through the lime drums, becomes a saturated solution containing 70 grains per gallon, and is then passed through Venturi tubes at the requisite rate.

The filters are washed once every 24 hours with water from the adjoining filters, which passes the reverse way through the filters; the sand meanwhile being agitated by a series of arms on a central revolving shaft in each drum. These arms are hollow, and have jets through which the water passes; thus thoroughly cleansing the sand. On the ends of the arms are extensions which scrape the sides of the drum to prevent the sand, and any detritus which has crept down the sides, from adhering and becoming foul.

The whole of the power for the plant is obtained from the compensation water, which, when required for this purpose, is passed through a 10 H.P. Gunther turbine. This also drives a dynamo with battery of accumulators, which provides all the lighting required on the works, including the reservoir keeper's house, valve-house, &c. A 12 H.P. Tangye oil-engine is also provided as a stand-by to the turbine. The wash-water passes into two settling-tanks outside the house, and after the clean water has been decanted off into the stream, the detritus deposited is pumped on to the adjoining land by an electrically driven pump.

[As showing the experience gained with mechanical filtration, which has been working at Stockport since September, 1912, the President gave a series of tables, from which we extract the following figures for the beginning and the end of the period named. The results are expressed in parts per 100,000.

| Date. | Sept. 6, 1912. | | April 21, 1914. | |
|---|---|---|---|---|
| | Unfiltered. | Filtered. | Unfiltered. | Filtered. |
| Free ammonia . . . . . | 0·006 | 0·006 | 0·0040 | 0·0026 |
| Albuminoid do. . . . . | 0·008 | Trace | 0·0054 | 0·0024 |
| Oxygen absorbed, 4 hrs at 80° Fahr. . | 0·358 | 0·033 | 0·160 | 0·028 |
| Plumbo-solvency at 24 hours . . . | 0·70 | 0·08 | 0·06 | .. |
| Bacteria on gelatine in 72 hours at 18-22° C. . . . . | 248 | 11 | 21 | .. |

The President pointed out that these results were obtained with the water which first entered the new reservoir, and, as there is no bye-channel, the flood water passes through the reservoir, causing the supply to be very turbid at times. But even in these adverse circumstances the results were in every case satisfactory, and the water supplied was bacteriologically, chemically, and physically of excellent quality.]

### Service Reservoirs.

The filtered water is passed into a covered concrete reservoir 10 feet deep, with a capacity of 500,000 gallons, divided into two parts; the T.W.L. being 810 O.D. The plant is automatically controlled from this reservoir; the flow of water through the filters and the working of the motors pumping the alumino-ferric solution and the supply of lime water being regulated by the rise and fall of the water-level in the reservoir.

From this reservoir the water flows along the 27-inch main, laid in 1907, to Jacksonsedge, Disley, where there is a covered reservoir 20 feet deep, constructed of reinforced concrete, with a capacity of 4 million gallons; the T.W.L. being 770 O.D. The foundations were in Yoredale shales and grit; and, being very wet, the structure is underdrained. As in dry weather the outlet of these drains is absolutely dry, there can be no doubt as to the water-tightness of the reservoir. The floor is 12 inches thick, with steel fabric reinforcement; the roof is flat, and 6 inches thick, supported by reinforced beams carried on reinforced columns 14 inches square—the columns being 14 and 15 feet centres. The walls are 23 feet high from floor to roof, and taper from 19 inches to 10 inches thick. They are buttressed outside opposite the beam lines; and the north-easterly wall is buttressed on both sides, to provide for the future duplication of the reservoir on this side. As practically the whole of the reservoir had to be excavated, the cost was proportionately high.

The water flows into the reservoir through a triple ball-valve which shuts off at different levels as the reservoir fills. From this reservoir the water passes through a water-column Venturi meter fixed on a 24-inch main towards the borough of Stockport; the pressure being reduced from 72 to 17 lbs. per square inch by means of a pressure-reducing valve fixed at 600 O.D. The 24-inch main divides at Hazel Grove into two 15-inch mains, one of which is laid through the westerly portion of the district to Alderley Edge, where there is a balancing reservoir to hold 2 million gallons (depth 14 feet T.W.L. 605 O.D.). This reservoir is circular, and of similar construction to that at Jacksonsedge.

Owing to the peculiar nature of the foundation, which consists of bands of soft sandstone and pebble sandstone interlined with beds of soft red shale which on exposure puddled, the floor, originally designed 12 inches thick with one layer of steel fabric, was made 15 inches thick with two layers, and an extra layer 7 feet square under each column. The walls taper upwards from 13 to 7 inches thick; the roof is 6 inches thick, carried on reinforced beams with 10-inch columns at 15-feet centres.

The water is delivered to, and taken from, this reservoir at the floor-level; and on the pipe is to be fixed an automatic throttle-valve to prevent the emptying of the reservoir in case of the fracture of a main.

# GEOLOGICAL STRUCTURE OF THE STOCKPORT DISTRICT.

At the Summer Meeting of the Institution of Water Engineers at Stockport, a general report of the proceedings at which was given in the "JOURNAL" last week, Dr. GEORGE HICKLING, F.G.S., delivered a lecture, illustrated by lantern slides, on "The Geological Structure of the Stockport District." He prefaced it with the remark that it would be an impertinence on his part if he were to attempt to deal with water supply questions, but, on the other hand, it seemed clear that what he had to say with regard to the geology of the district should have some relation to problems of the water supply; and therefore he was endeavouring to give information of such a character as to show how the physical features of the region were related to its geological structure, and incidentally how the problems of water supply in the area were related to its geology. He proceeded to deal with his subject.

### GROUPING AND CHARACTER OF THE ROCKS.

Of various possible methods of grouping the rocks of the locality, he selected that by which the Carboniferous Limestone formed one group, the Pendlesides, Millstone Grit, and lower coal measures formed another definite group, and the rest of the coal measures were again a distinct group, while the Permian and Triassic rocks were grouped together as having very few distinguishing features, being better united for present purposes under the general name of the New Red Sandstone. The Carboniferous Limestone of Derbyshire was remarkable for its extreme purity and massiveness. The full thickness of it was unknown, because the base of it was nowhere exposed; but the exposed portion was known to reach a thickness of 1500 feet, and there was reason to believe that the thickness of the unexposed portion might be very considerable. It was characterized by very thick beds—often 10 to 20 feet in thickness—and also by the development of very strongly marked vertical joints. The actual separation of the various beds of limestone one from another was usually of a very pronounced character; and the result was that the division-lines between the various beds of the rock formed natural planes which the water sought out for its flow, so that almost invariably it was found that there was a good deal of erosion between successive beds of limestone—often a very striking feature when these surfaces were exposed. The vertical joint planes also formed natural lines for the flow of the water, with a measure of importance which would be seen later.

The Pendleside rocks, as they were called in that district, were mostly shales with numerous fine beds of sandstone and one thick bed of hard grit in the middle of the series. The general character of these Pendleside shales was illustrated in an escarpment on Mam Tor, near the village of Castleton, in North Derbyshire. The bedding of these rocks was exceptionally prominent in that case, owing to the rapid alternation of thin sandstones with shales. The Millstone Grit was essentially, from the point of view of physical character, a continuation of the Pendleside series of rocks; the difference being that in the Millstone Grit series the bands of grit were more highly developed relatively to the shales. The Millstone Grit usually formed very prominent features in the landscape. In that district there were generally four recognizable bands of grit. The total thickness of the series was about 2500 feet, and the lowest grit, named the Kinder Scout Grit, from the fact that it formed the cap of the Peak itself, was much thicker than any of the others. It was the thickest and most massive of all the grits. The three higher grits were usually much less coarse in character, and the second grit in particular was generally flaggy rather than gritty in type. A very important feature was the very rapid variations in thickness and character to which the grits were liable. In going southward from Stockport, the grits thinned with extreme rapidity, and as they thinned they altered in character. This was particularly noticeable in the case of the Kinder Scout Grit. The thickness of this at its maximum was about 1000 feet, and within ten or fifteen miles it thinned down to about a quarter of this, split into two beds, became quite insignificant, and finally died off altogether. Northward from Stockport the Millstone Grit thickened out still further; and when they reached North Lancashire they once more got a diminishing series. It was of great importance to bear in mind always the rapidly varying character of the grits.

The Lower Coal Measures were, from the physical point of view, merely a continuation of the Millstone Grit series. The Middle and Upper Coal Measures did not form any pronounced features in the district. They differed from the grits in consisting mainly of shales and clays with only subordinate beds of sandstone; the latter, as a rule, being not sufficiently thick or massive to produce any pronounced features on the surface.

Then there was the New Red Sandstone. By far the greater part of this in the neighbourhood consisted of fairly coarse very soft sandstone, which showed in a very pronounced degree the feature that it was scarcely ever arranged in clearly defined parallel beds like the great majority of sedimentary rocks, but nearly always exhibited the phenomenon of current bedding or false bedding. Thus it was characterized by a type of structure not generally found in rocks which had been deposited by water, but strongly developed when there was a series of sand-dunes on a land surface where the sand was continually being redistributed by the wind. This indicated that these deposits were mainly of desert origin, and not accumulated under water. The almost continuous mass of soft irregular sandstone was interrupted by three deposits of different types. The lower Permian rocks, as seen on the banks of the Mersey, were typical of this sandy character; but they were overlaid by the thin mass of upper Permian, consisting of bright red marls, which, however, were exposed over an extremely small area. The lower Triassic rocks were also entirely of the sandy type; but the upper Triassic were much more varied. At the base of the upper Triassic was the most prominent band of rock in the whole of the red sandstone series in that district, as might be seen in the hills about Alderley Edge. It was the only hard band of rock in the whole of the New Red Sandstone series, with the result that wherever it came to the surface it formed extremely prominent escarpments of the type to which he had referred. All round the Triassic basin of Cheshire these were conspicuous. On the opposite side of the basin they came up again in Delamere Forest. This "Basement Bed" of the Upper Trias was in turn covered by another sandy series, somewhat more compact than the others, and that finally was overlain by the great mass of soft red marls which form the greater part of the low fertile plain of Cheshire.

### RELATION OF THE ROCKS TO EACH OTHER.

Now as to the arrangement of these rocks relatively to each other. In that neighbourhood they were situated on the western side of the great arch of rocks which forms the Pennine Chain, in which the rocks were superimposed in the order in which they had been described. It was only in Central Derbyshire that the Carboniferous Limestone actually reached the surface, in the centre of the arch. In this southern portion of the Pennines, however, the arrangement was not so much that of an arch as a dome. Not only did the rocks dip away from the Pennine Chain to the west and downwards again to the east, but there was also a downward inclination to the south and a northerly dip in the neighbourhood of the Peak itself.

The strata in the immediate neighbourhood of Stockport were divided by the great "Red Rock" fault, which threw down the Triassic rocks against the Carboniferous, and thus brought together two very sharply contrasted types—the soft Triassic rocks, which produced no surface feature, were brought side by side with the Millstone Grits of the Carboniferous series with their very pronounced alternations of thick massive hard grits and soft shales, making a very pronounced contrast. The result was the Plain of Cheshire, almost dead-flat, sharply marked off from the extremely irregular country of the Millstone Grit area. In that neighbourhood, as the lecturer showed by means of a lantern slide of a model, instead of the rocks dipping evenly to the west away from the centre of the Pennine Chain, the uniform slope of the rocks had been broken by a second arch and trough. There was a subsidiary anticline outside of the main anticline. As the structure of this subsidiary arch was followed in the model from south to north, the arch broadened out, and it began to crack and break up, and, in place of comparatively unbroken rocks brought up in a pronounced fold, there were rocks which were cracked in all directions, and very extensively displaced by faults. Then, further north, it became a pronounced arch again, and was seen once more to be comparatively unfaulted.

Another important point was the relationship of the New Red Sandstone rocks to the Coal Measures. In the neighbourhood of Manchester the New Red Sandstone rested on the Upper Coal Measures. In that region the whole thickness of the Coal Measures occurred underneath the New Red Sandstone series. As they went southwards, the New Red Sandstone rocks themselves sank deeper and deeper below the surface; but at the same time the thickness of the Coal Measures underlying them gradually decreased, so that in the southern section they had the New Red Sandstone overlying an extremely small thickness of the Middle Coal Measures with the Lower Coal Measures underneath. In fact, in all probability, in the neighbourhood of Alderley Edge the New Red Sandstone rested directly on the Lower Coal Measures. In other words, as they went southwards they got a very pronounced overstep by the New Red Sandstone on to successively lower horizons of the Carboniferous rocks—a point of very great importance in regard to the extension of the South Lancashire coalfield underneath the newer rocks of Cheshire. This district was still almost entirely unexplored; but, as other parts of the coalfield became more and more exhausted, this coal would be worked, and the point would become of extreme importance.

### GEOLOGICAL STRUCTURE AND TOPOGRAPHY.

As they had now an idea of the nature of the rocks of the district and of their relationship to each other, it remained to see how the character and relationship of these rocks affected the general character of the country itself. He had already remarked on the importance of the joints in the Carboniferous Limestone as forming natural passages for the water flowing over it. Then they had to remember also that the limestone was very readily soluble in rain water. So they found that all the rivers of the limestone area tended to have their courses largely controlled by the joints. They tended to eat their way along joint planes, and, on account of the great solubility of the rock, the rivers tended to erode extremely deep gorge-like valleys with almost perpendicular sides in the majority of cases, like that of Miller's Dale. In general, with regard to the limestone area, they might say that it formed a plateau. The limestone did not in itself tend to produce any pronounced surface features, but it became dissected by these

extremely deep gorge-like valleys, commonly 500 or 600 feet in depth; and from the plateau on top one could look over these valleys one after another and never have a moment's suspicion of their existence. This made a very remarkable type of country. The ready solution which took place along the joints in the limestone produces remarkable effects, as in the valley of the Dove. The rain had run freely along certain vertical joints, and as a result had worn out remarkable pillars which were prominent features of most of the limestone valleys of the neighbourhood. Perhaps the most striking feature of the limestone area was the fact that the great majority of the valleys in that area were dry. The valley of the "Winnats," near Castleton, was apparently a perfectly typical river valley of a great depth; but there had never been in recent times any trace of a stream. The reason was that, on account of the extreme solubility of the limestone, the water everywhere sank through it straight away down to the natural water-level, which was usually about 500 feet below the surface of the limestone plateau, with the result that any valley the bottom of which was above the natural water-level was almost invariably a dry valley. The ready percolation along the strong joint planes resulted in the production of enormous caves in limestone. These joints, being attacked by the water in its course, were widened out into huge caverns, such as the Blue John Mine, with rivers running through them. By far the larger part of the rivers of the limestone area were subterranean, so from the water point of view the limestone area was of a very unusual character.

### The Millstone Grits and Water Supplies.

The lecturer now came to the most important area—that of the Millstone Grits. This, he said, might be broadly described as a series of moors. As a general rule, the grits themselves would only support a growth of coarse grass and heather, which very commonly gave rise to a thin deposit of somewhat poor peat. The intervening shales supported a somewhat richer growth; but the whole area was generally very barren in character. The effect of these alternating hard grits and soft shales was nowhere better shown than in the magnificent hill of Kinder Scout. The top of this was almost a flat table of what was called the Kinder Scout grit, limited by precipitous edges where the grit cap had broken away owing to the erosion of the soft shales below. Where the Millstone Grit was not horizontal but inclined, one had the type of thing seen in Ashop Clough. The grits, as before, resisted erosion very powerfully, while the shales were removed with ease; and so, where originally there might have been a horizontal surface, the inclined shale had worn away and given rise to a valley, laying bare the sloping surface of the grit below, and undermining the grit above. As the latter grit was undermined it broke off, and produced a steep escarpment; and so there resulted an extremely characteristic type of valley which had a dip-slope on one side and a steep escarpment on the other. The great majority of the valleys in this neighbourhood were of this character; and a good illustration of it was found in the wide valley to the east of Chinley Churn, where the valley had been almost entirely excavated by the rain alone. Each step also on the side of Chinley Churn itself marked the outcrop of one of these bands of grit left after the washing away of the shale.

These facts had a very important bearing on the water supplies of the Millstone Grit areas, as was illustrated by a map of the area east of Stockport, where the water-works of the Stockport Corporation were situated. This area was really the main line of the Mersey Valley, and the form of the valley at each point was entirely dependent upon the character of the rocks over which the river was flowing. Between Kinder Scout and the outcrop of Kinder Grit near Hayfield where the water was flowing over Pendleside shales, the valley was extremely broad and had two large tributary valleys. As soon as the valley came to the grit, it narrowed down to a pronounced gorge. As it got beyond the grit and into the shale again it widened out once more until, coming in turn to the upper grits, it narrowed at the village of Birch Vale. Again in the softer Coal Measures it widened out; but on reaching the uppermost grit at New Mills it was narrowed to an extremely pronounced winding gorge. This alternation of open valley and gorge was typical of the course of every one of the main rivers flowing away from the Pennine Chain, all of them flowing across the successive outcrops of grit and shale. It was this feature which had determined the location of almost every one of the catchment reservoirs of the water supplies of the northern counties of England. The wide extensions of the valleys where the shale was crossed formed natural sites for reservoirs, and the narrow places where the valley crossed the grit formed natural barriers where a minimum of artificial embankment was necessary to impound the drainage.

### Landslides and Reservoir Embankments.

One more point. There was an extraordinary number of landslides in this neighbourhood, and they were of great importance from the point of view of reservoir building. A view of an escarpment showed the extremely free manner in which these rocks broke up. The joints of the grits were very pronounced. Frequently they were actual open fissures a foot or more in width; and the result was that when the shales below these grits were weathered the grits themselves broke up with extraordinary ease into great blocks in the manner shown on the top of Blackstone Edge. As the weathering went on there was a constant falling of the grits on the steeper sides of the valleys, and constant sliding of the grit and shales together into the valley bottom. As in the case of Mam Tor, there were a great number of landslides constantly going on. They did not happen once in a thousand years, but were constantly on the creep. Every one of the landslides in Mam Tor was making its way to the bottom of the valley. It was a fact of the greatest importance that on the steep sides of these valleys there was an enormous amount of material creeping constantly towards the bottom, and crushing the bottom of the valley, since it resulted that whenever a section was cut across the bed of one of these valleys—whether for the building of an embankment or for any other purpose—they found almost invariably that the shales at the bottom of these valleys were intensely contorted. The important point was that the contortions of these shales were not, so to speak, true "geological" folds, but were merely due to the surface movement of the rocks; and that while the surface rocks were crumpled in this way, if they went down to a reasonable depth, they could usually cut through this surface-crumpled rock, and get down into the sound, unbent rock below, and so get a better sort of foundation for any embankment which might have to be made. This was a point, of course, which had to be very carefully attended to in the construction of dams in these Pennine valleys.

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At the close of the lecture, the President (Mr. T. Molyneux, Assoc.M.Inst.C.E.) voiced the thanks of the assembly to Dr. Hickling, observing that they were all deeply indebted to him. Though he (the President) was very well acquainted with the local geology, he had been extremely interested; and he knew that Dr. Hickling must have found it very difficult to summarize in so short a time so much that was important.

## NOTES FROM ABROAD.

**Vicious Dog Obstructs Meter Inspectors.**

It is by no means an uncommon thing in England for a man sent to deliver goods inside a house to inquire of the occupant whether or not there is a dog upon the premises, as, if there should be one of unusual vigilance, a stranger is liable to meet with injury. It appears that the meter inspectors of the Central Indiana Gas Company of Anderson (Ind.) have been prevented from carrying out their duties at the Henry Malone Home on account of the presence of a vicious dog. It is reported that one man was, from this cause, kept a prisoner in the basement of the house for half-a-day. The Company have reported the matter to the police, who have promised to aid them in every way. They have been authorized to turn off the gas if the dog is not muzzled or properly penned up.

**Coke Production in the United States.**

According to figures furnished by the United States Geological Survey, all records in coke production were broken last year; the output being 46,311,369 short tons, valued at $128,951,430. This is an increase over 1912 of 2,327,770 tons in quantity, and $17,146,317 in value. Of the 1913 production, 33,296,669 tons were made in beehive ovens, and 12,714,700 tons, or 27·4 per cent., in retort or bye-product ovens. The increase in production of the latter class of coke was more than twice as large as the increase in beehive coke. A large part of the coal used in bye-product ovens in States that do not produce coking coal was obtained from West Virginia mines; the quantity of this coal made into coke outside the State being estimated at 7,800,000 tons. The quantity for West Virginia was 4,034,251 tons.

**German Coke Market.**

The market for coke in Germany remains very bad, and stocks are high, especially in the Berlin district. Summer prices have been fixed at a reduction of as much as Mk. 10 per 10 tons, in order, if possible, to clear large quantities before the end of September. The keenest competition is being felt from lignite briquettes, which are constantly increasing their sales, helped by extensive advertising. To meet this competition more effectively, the chief coke producers and sellers have established a joint bureau in Berlin, where the advantages of coke are to be demonstrated practically, and suitable propaganda issued. The organizers are expecting much good to come from this organization, especially in the education of the users of solid fuel; but at the same time they urge that gas-works should lose no individual opportunity of increasing their markets.

**Gas Consumption and Bye-Products in Germany.**

The German Gas Publicity Centre has issued the usual monthly statistics showing the results of the member gas-works for January and February. In the former month, 712 comparable undertakings had an increase of 3·1 per cent. as against the previous January. The number of meters installed by 649 works were 7·7 per cent. more. The figures for February were 2·2 per cent. increase for gas and 8·1 per cent. increase for meters. The German Ammonia Sales Association reports that the sulphate market showed no activity in May; the only buyers being America. The inland production remained about the same as in May of last year. The benzol market suffered from the competition of heavy benzine, the prices for which were considerably reduced during the month. Greater quantities were placed than in May of last year, but the supply remains ample to meet requirements. The demand for toluol was not entirely satisfactory.

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# CORRESPONDENCE.

*[We are not responsible for opinions expressed by Correspondents.]*

## The Enlarged "Field"—Calorific Values and Omissions.

SIR,—Following on my general remarks in your last issue with regard to the enlarged "Field's Analysis," I should like to say I have found the particulars of the calorific value therein stated so useful that I compiled the enclosed table of comparison for an interview that the Gas Companies' Protection Association had with the Lord Chairman yesterday.

The deduction from the table is that at or about 14 candles illuminating power the British thermal units would come to 36·86—say 37—for each candle of illuminating value, on the average of ten important undertakings in Field; and for the remaining five in the table, including, for the most part, undertakings purporting to give 16 to 18 candles, and probably enriched by carburetted water gas, the average British thermal units are 33·16. You will see that in the table the Commercial Company's return is put at its correct value of 527 gross thermal units, instead of the net value, which, as Mr. Stanley Jones has explained to you, was furnished by his officers under a misapprehension.

The point of this table is shown in the inevitable conclusion from it, that in the recent settlement of the penalty point of the Gas Light and Coke Company the old margin of a half-candle below the ideal 14 is preserved to the Company, as under the table the equivalent for 13½ candles is practically 498 B.Th.U. I had to point out to his Lordship that with companies of small scale, and in many cases, by geographical conditions, compelled to use special coals, such a standard was not maintainable, and that generally somewhat lower figures should be given to the various smaller companies throughout the kingdom, which would be best arrived at by a consideration of the special circumstances they would all be able to put forward, rather than by following any "cast-iron" figure; the desirable object in every case being to enable the undertaking to supply the greatest amount of *heat* at the lowest possible price. This is practically what I said when in the witness-chair on the Gas Light and Coke Company's Bill.

Finally, on this point, it is very clear that there is a distinct relative proportion between the illuminating power and the calorific value, excepting where a large proportion of carburetted water gas may be included.

In looking through "Field's Analysis," it is unfortunate to miss all municipalities in Ireland. Belfast, which is a capital criterion, and somewhat larger than the Dublin Company, should be included, if possible; and I should think there would be no objection to it. Again, among the corporations we have three important ones from the Midlands, three from the North-East, three from the North-West, and two Scotch, but no Irish. In the companies we have two important ones in the North-East, none from the North-West (and would like to have Liverpool); we have a very good one from the Midlands, and no less than six from the South-East and South-West, much less important in scale.

When I turn to the very valuable publication by the "Gas World," I again fail to find Liverpool. Can we not prevail on your correspondent, Mr. William King, to get this into Field's and other analyses? But, above all, let us get gallant little Widnes, with its wonderful low prices.

*Palace Chambers, Westminster, S.W., June 18, 1914.* HY. E. JONES.

[ENCLOSURE.]

RELATION BETWEEN ILLUMINATING AND CALORIFIC VALUES.

[From "Field's Analysis" for 1913.]

| Undertaking. | Illuminating Power Supplied. (Candle Power.) | Calorific Value Supplied. (B.Th.U. Gross.) | B.Th.U. per Candle Power. | Percentage of C.W. Gas. |
|---|---|---|---|---|
| Gas Light and Coke Company | 14·35 | 524 | 37·2 | 18 |
| Commercial Company | 14·61 | 524 | 36·0 | 32 |
| South Metropolitan Company | 15·51 | 571 | 37·0 | — |
| South Suburban Company | 14·25 | 520 | 36·5 | — |
| Wandsworth Company | 14·40 | 136 cal. / 540 | 37·5 | 8 |
| Croydon Company | 14·40 | 543 | 37·7 | 19 |
| Hornsey Company | 15·24 | 550 | 36·1 | 21 |
| Birmingham Corporation | 15·70 | 577 | 36·8 | 18 |
| Bradford Corporation | 17·00 | 617 | 36·3 | — |
| Derby Company | 15·52 | 582 | 37·5 | — |
| | | Aver. | 36·86 | |
| Portsea Island Company | 14·38 | 475 | 33·1 | 30 |
| Manchester Corporation | 16·88 | 570 | 33·8 | 19 |
| Bath Company | 17·40 | 600 | 34·5 | 19 |
| Glasgow Corporation | 18·05 | 570 | 31·7 | — |
| Oldham Corporation | 18·08 | 590 | 32·7 | 10 |
| | | Aver. | 33·16 | |

## The Price of Tin.

SIR,—I gather from the letter of "Manufacturer" that the gas industry is not to benefit by the present low price of tin, because he—and assumedly others—have made contracts for supplies running over a year.

Are we also to assume that these contracts bar them from buying in a free market when, as now, the opportunity arises to buy at very low prices?

One would expect that any trader having purchased at any price near the late maximum, would now avail himself of this opportunity.

If this is done, the buyers in the gas industry should reap some advantage. If it is not done, will "Manufacturer" kindly explain why?

*Taunton, June 19, 1914.* A. EDWARDS.

## Recovery of Ammonia.

Sir,—With reference to the "Editorial" in your issue of June 16 on the "Direct Ammonia Recovery Process," I have just returned from a visit to Germany; and it is rather astonishing to find that there—the home of the process—ordinary gas-works ammonia recovery is still being installed at some of the new coke-oven plants under erection.

One colliery company in particular, whose annual make of sulphate of ammonia exceeds 20,000 tons, and who presumably should know something about ammonia recovery, are erecting two plants with the old process, though they already have two plants working with the "direct process."

Though "One swallow does not make a summer," it would appear that the direct process has disadvantages not yet disclosed to the gas industry.

*Leeds, June 19, 1914.* OBSERVER.

## Institution of Water Engineers' Membership List.

SIR,—In your report of the meeting at Stockport, I regret to find that the list of members elected and transferred since the last meeting contained two errors which I wish to correct. The name "George F. Anderson," of the Fylde Water Board, should have been "George F. Atkinson," and the transfer of Mr. Waddingham, of Grimsby, to the class of members should not have appeared.

It is only fair to state that these errors were due to secretarial oversight, and not to any failure on the part of the "JOURNAL." Will you therefore kindly publish my apology to the gentlemen concerned, as well as to any of your readers who may have been misled.

PERCY GRIFFITH (Secretary).

20, *Victoria Street, S.W., June 20, 1914.*

# REGISTER OF PATENTS.

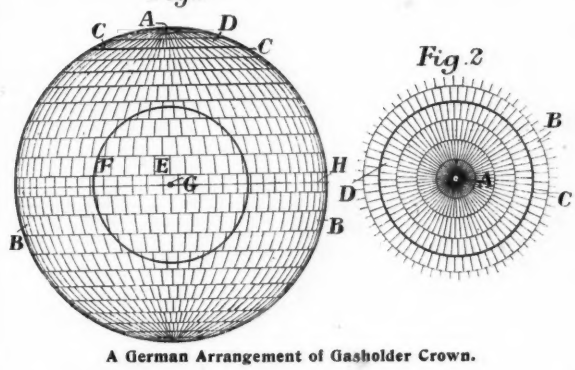
## Gasholder and Tank Covers.

BERLIN-ANHALTISCHE MASCHINENBAU-AKTIEN-GESELLSCHAFT, of Berlin.

No. 3356; Feb. 9, 1914. Convention date, April 9, 1913.

This invention relates to covers or roofs for gasholders, tanks, &c., when the cover is in the form of a segment of a hollow sphere composed of a series of plates.

Hitherto such covers have been formed, the patentees remark, from plates the edges of which radiate from the centre of the cover, which may be regarded as constituting one of the poles of the imaginary sphere of which the cover forms a part. These plates have been arranged in zones or belts concentric to the pole of the sphere or centre of the cover. But, according to the present invention, the segment of the imaginary sphere which is selected to constitute the cover has for its centre a point on the equator of such imaginary sphere; so that the plates form parallel bands or strips, instead of concentric circles or zones. By this arrangement the number of plates constituting the cover, and consequently the number of joints required, is reduced; while, further, "there is not the waste of material inseparable from the use of trapeze-shaped plates hitherto employed."




**A German Arrangement of Gasholder Crown.**

Fig. 1 shows a complete sphere in elevation. Fig. 2 is a plan of the segment adjoining one of its poles from which covers of the type described have hitherto been formed.

While hitherto one pole A of the sphere B formed the centre of the cover D limited by the circle C, the new cover is constituted by plates situated within the circle F. A comparison of fig. 2 with the portion enclosed by the circle F in fig. 1 "shows the essential advantages of the invention—namely, a considerable reduction in the waste of metal, and more particularly in the number of riveting seams; so that the cost of manufacture is very much smaller than hitherto."

The most favourable conditions obtain when the centre G of the circle F is situated on the equator H—that is to say, "when the equator of the imaginary sphere of which the cover forms a part passes through the centre of the cover."

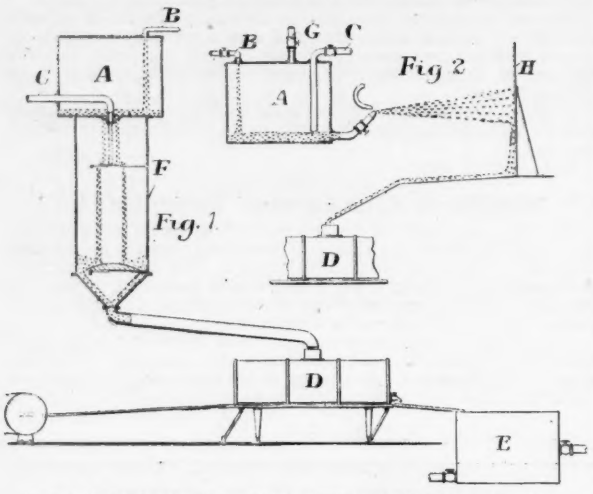
## Removing Deleterious Substances from Tar, Tar Oils, or Pitch.

ROSS, H. C., of Chelsea Gardens, Chelsea.

No. 11,984; May 22, 1913.

This invention relates to means for removing more especially such substances as have been found to exercise an injurious action on

workers engaged in handling tar or its derivatives—substances known as "auxetics," which the patentee says he has found capable of exciting reproduction of certain human and other animal cells when removed from the body, upon which fact he has founded a working hypothesis as to the cause of cancerous and other growths.




**Ross's Apparatus for Removing Deleterious Substances from Tar.**

Fig. 1 is a diagram showing one type of apparatus which may be used for washing the tar; and fig. 2 a similar view showing a modified type of apparatus.

A is the tar-tank; B, a supply pipe for the tar; C, a hot water supply pipe; D, a shaking vessel receiving the mixed tar and water; and E, a settling tank.

In fig. 1 the tar is continuously supplied to the tank A at a regulated rate through the pipe B, so that the bottom of the tank is covered to a small depth. The tar outlet is formed by a perforated discharge cap; the water-pipe C terminating in a rose at the middle of the outlet. The mingling streams of water and tar then fall on to a horizontal plate or disc in the tank or casing F (preferably about 3 feet below the outlet) over the edges of which plate the water drives the tar, breaking up both water and tar into small drops, which fall through a further distance of about 10 feet on to a convex plate. This plate, by throwing the mixture off against the sides of the vertical enclosing tank F, causes finer division and more intimate mixing of the tar and water. The now finely-divided and mingled materials flow from the conical bottom of the tank F into the container D, which is shaken through its connection with a crank disc driven by a motor, until all soluble material has been removed from the tar. The shaking operation should continue for an hour or more after the vessel has been fully charged. The mixture may then be drawn off to a settling tank E for decanting the greater part of the water or solution through the discharge pipe. The wet tar which has settled may be removed through the tar discharge pipe to a mechanical separator of any suitable description, from which the tar can be obtained in a sufficiently dry condition to allow of distillation or other treatment.

In fig. 2 the tar-tank A is closed and adapted to receive steam under low pressure from a pipe G. The hot water pipe C opens into the tank, and does not pass through it as in the previous construction. The tar and water escape through the jet outlet, to which a steam jet is applied so as to form a fine spray, which is dashed with some force against a mixing plate H; thence dropping on to a plate or trough leading to the shaking vessel D. The steam for the spraying jet may be at a higher pressure than that used in the tank. The shaking and settling operations follow as in the apparatus previously described.

The auxetics are, it is said, readily oxidizable; and, on oxidation, they lose their injurious properties, so that they may be removed or destroyed by passing air or oxygen (which may be ozonized) through the tar during distillation or at any convenient stage of the manufacturing process—care being taken to bring the oxidizing agent into intimate contact with all parts of the tar, by employing, for example, air jets under the tar or circulating air or oxygen in the retorts.

## Drawing and Charging Gas-Retorts.

BIRD, H., and HAYTER, G., of Hayes, Middlesex.

No. 12,976; June 4, 1913.

This invention relates to the charging of gas-retorts by means of a scoop which is inserted by a chain in which the links are in compression—the coal being held in position in the retort while the scoop is being withdrawn by a frame and plates operated by a chain rod independently of the scoop. The scoop is adapted to be travelled longitudinally and transversely of the retort-house and to be raised and lowered and swing horizontally on a pivot, so as to be placed in position for being filled with coal and for charging the retort.

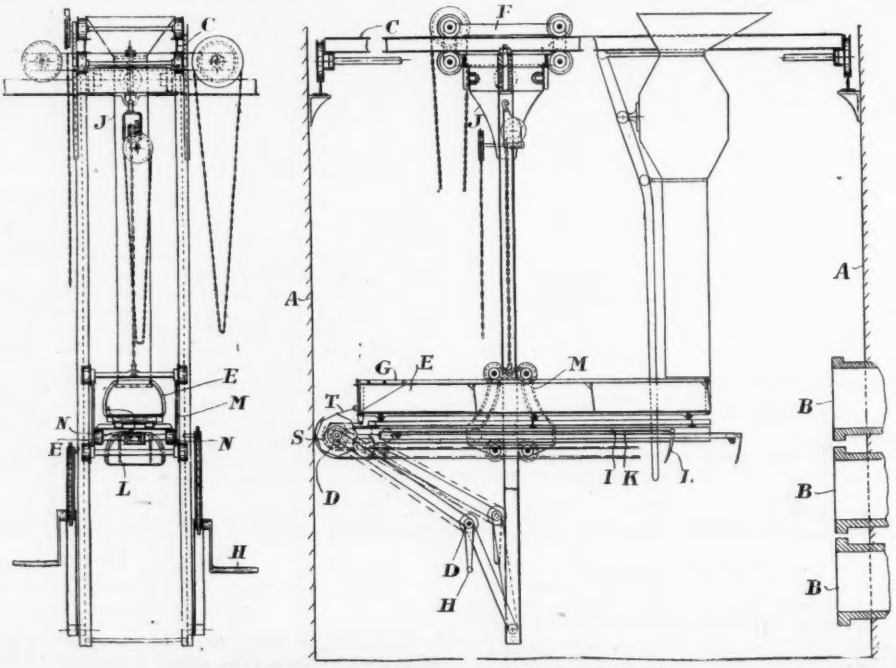
An elevation is reproduced of apparatus made in accordance with this invention; also a side view.

A are the walls of the retort-house; B, the retorts; C, a traveller provided with wheels D adapted to run on rails. A carriage F is also provided with wheels adapted to run on the traveller. Vertically disposed H beams are mounted on a frame J centred so as to form a turn-table. A cradle M, adapted to travel between the vertical beams, is provided with longitudinal channels and guide wheels, and is thus adapted to be raised and lowered by endless chain gear. On the channels N (or brackets suitably disposed) are mounted polygonal pulleys adapted to operate chain rods.

The scoop E is formed of a plate shaped to fit the retort; and a chain rod passing over the pulley S is attached to the scoop. Within the scoop is disposed a channel iron frame G carrying hinged plates adapted to resist a thrust in one direction. Between the channels N are disposed two other channel irons; while polygonal pulleys are mounted on one of the channels over which ride chain rods adapted to thrust and pull the channels so as to telescope into one another, and move in relation to the channels N.

In operation the scoop is filled with coal from a hopper or otherwise, and travelled to any desired position of the retort-house by means of the travelling crane. It is then raised or lowered to the level of the retort mouth by means of the cradle, and swung into a position to enter the mouth of the retort. The end of the scoop is then run into the mouth of the retort. The scoop and frame G are then travelled forward by the handles H into the retort; and the scoop is withdrawn by turning the handle in the opposite direction—leaving the frame and hinged flaps in the retort. In this manner the coal is held in the retort and evenly distributed. The frame is withdrawn by the chain rod T; the scoop remaining stationary until the end of the frame strikes the end of the scoop. On continuing the motion, both the frame and scoop are retracted together until both are withdrawn to a position ready to be refilled with coal.

When it is desired to withdraw the coke from the retort the telescopic beams I and K are pushed forward in the retort by chain rods; the beam K travelling at twice the rate of the beam I. The end plate and rake L ride up on their hinges, and thus easily travel over the coke on their journey in; but when the telescopic beams I K are withdrawn by a contrary motion of the chain rods and pulleys, the end plate and




**Bird and Hayter's Retort Charging and Drawing Apparatus.**

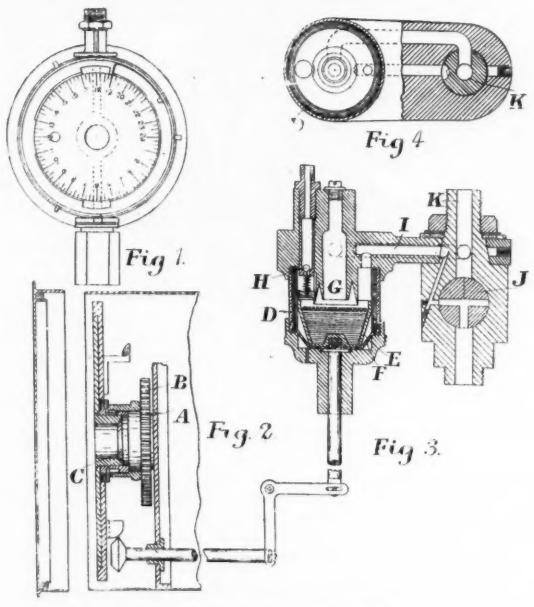
rake catch on the coke and dig into it and draw it out of the retort. The beam K travels at twice the speed of the beam I, so that when withdrawing them they both reach the limit of the return journey at the same moment.

## Controlling the Supply of Gas to Burners at Predetermined Times.

RADET, L., of Paris.

No. 12,658; May 30, 1913. Convention date July 17, 1912.

The invention is carried out as follows, reference being made to: Fig. 1, a front view of the apparatus from the dial side, with the cover removed; fig. 2, a transverse section on a larger scale of the dial with the tappet arms; fig. 3, a vertical section of the automatically operated valve; fig. 4, a part transverse section of fig. 3.




Radet's Gas-Lamp Controller.

The apparatus consists essentially of two parts—a mercury valve for controlling the supply of gas to the main and pilot burners, and mechanism (to move the valve at predetermined times) operated by clockwork (not shown) placed behind the plate A. A toothed pinion moved by the clockwork drives the tooth wheel B, carrying the socket C, on which is mounted the dial graduated to represent the twenty-four hours of the day.

The working of the apparatus for lighting and extinguishing depends on the position of a vessel containing the mercury, connected to a disc P bevelled on either side and so disposed that it can be actuated by tappets joined adjustably to the back of the dial. These tappets are carried by arms behind the disc, each fitted at its centre of rotation with a circular collar of a thickness equal to half that of the arm, so that the thickness of the two collars does not exceed that of each arm. The arms are mounted by their collars on the boss of the dial, and a threaded ferrule, which screws on this boss, clamps the arms with their tappets to the dial plate in the positions desired.

One of the tappets Q is of such height and form that, when rotated with the dial into contact with the disc P, it engages the bevel facing it and forces the disc away from the dial. The other tappet R is bracket-shaped and at an angle with the dial plate, so that, when it is rotated into contact with the disc P, in its remote position, it engages its outer bevel and forces it back towards the dial. The position of the disc P controls the operation of the mercury valve in a manner to be described.

This mercury valve consists of a metal cylinder D, with an interior glass liner, in which is freely movable vertically a cup E, of ebonite, containing mercury. The cup is mounted on the upper end of a stem linked in any convenient manner to the disc P. Underneath the cup is disposed, in air-tight manner, a flexible membrane F secured to the sides of the cylinder, so as to prevent leakage of gas out of the cylinder while permitting the free movement of the cup in the cylinder D. The mercury is covered by a slight layer of glycerine, petroleum, or similar body adapted to keep it from contact with the gas and thus avoid oxidation.

A little above the surface of the liquid opens the tube G, which conducts the gas to the main burners. The rim of the tube is surmounted by a sleeve extending a little lower than the rim, and between them is provided a circular groove, the object of which is to prevent the projection of mercury into the upper passages of the plug when the tube is being sealed by the rising mercury. Any liquid splashed up is only projected into the groove, whence it falls back into the cup without penetrating into the central gas outlet tube.

At the side of the cylinder D is disposed a tube communicating with the pipe which conducts gas to the pilot burners. This tube opens into the cylinder by means of a small orifice, normally closed by the valve H, fixed at the upper extremity of a spindle, provided at its lower extremity with a head against which in rising the edge of the cup impinges. A spring tends to replace the valve on to its seat in the closed position. In fig. 3, the cup is shown in its lower position; and the surface of the mercury being below the edge of the sleeve, the gas which reaches the valve by the pipe I passes through the tube G, and on to the main burners, as the lower orifice of the tube leading to the pilot burners is closed. If, on the contrary, the automatic device acts so as to raise the membrane F and the cup E, the mercury seals the ends of the inlet tube to the main burners; and at the same time the edge of the cup raises the spindle head, against which it impinges, and with it the valve H, which opens the orifice of the bye-pass tube.

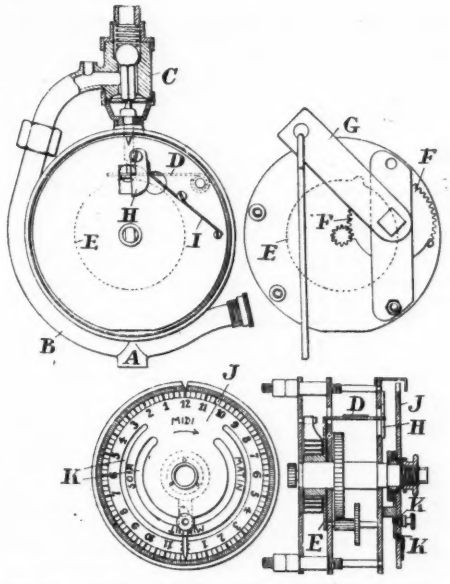
The automatically operated mercury valve described is combined with a three-way cock J, by which, when the valve is out of action, the gas can be either entirely cut off from or admitted direct to the burners. This cock is joined to the pipe leading to the burners, and is provided with two passages—one to conduct the gas to the automatically operated valve, the other to return to the pipe K, and to the burners, the gas passed by the valve.

## Extinguishing Gas-Lamps at Predetermined Times.

KILCHMANN, E., of Wohlen, Switzerland.

No. 12,778; June 2, 1913.

This is a clockwork device for extinguishing gas-lamps at predetermined times. It consists of a disc adapted to turn through one rotation in twenty-four hours, having a nose which lifts the valve into the open position, and an adjustable stop serving to withdraw the pivoted catch which keeps the valve open and to thereby close the valve. The device thus enables the automatic extinguishing of the lamps at any predetermined time irrespective of the number of hours the valve has been open.




Kilchmann's Gas Lighting and Extinguishing Device.

The device is screwed to the gas-conduits A; while a branch pipe B serves to convey the gas to the valve C, in which a ball is provided to normally close the valve. The ball can be lifted off its seat by the action of a pivoted lever D, thereby opening the passage for the gas to the lamp. For this purpose a disc E, having a projection at its circumference, is arranged on the spring shaft of the clockwork. The shaft also carries a pinion adapted to mesh with a toothed segment F, which is pivoted to the side walls of the device. A lever G is fixed to a square portion of the segment pivot, and is connected to a rod so arranged that it can be easily gripped by the lamp lighter. When pulling the rod the spring of the clockwork is wound up and at the same time the disc E is rotated through one complete revolution or more, so as to lift the lever D owing to the projection encountering a cross piece at the end of it. The lever is thereby lifted until a pawl or catch H, pivoted to the side wall, encounters the lever.

In order to secure a firm grip of the pawl upon the crosspiece of the lever, a spring I is provided which always tends to press the pawl against the lever. After the projection on E has raised the lever and thus lifted the ball off its seat in the valve C, the lever will maintain this position until the pawl H is caused to free it again; and it is for this length of time the lamps will burn. In order to extinguish the latter, the pawl H must be displaced against the action of the spring I, which displacement is effected by means of a dial J, which, being driven by the clockwork, completes one rotation in twenty-four hours. The dial is provided with slots K in which a stop pin can be adjustably fixed, so that at the requisite time it contacts with the pawl H and withdraws it from below the cross piece of the lever D, whereupon the ball returns on to its seat and closes the gas supply.

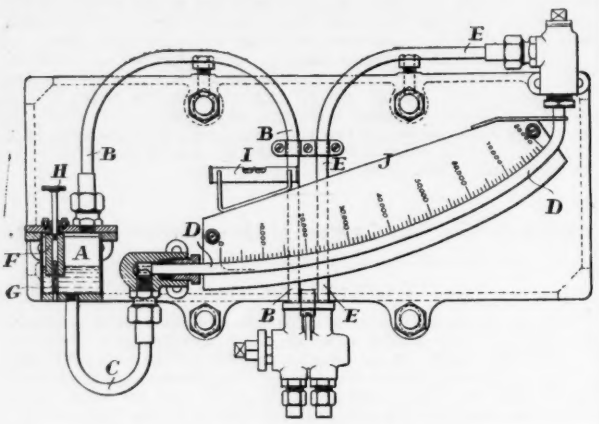
## Indicating the Quantity of Fluid Flowing through a Pipe.

HODGSON, J. L., of High Holborn, W.C.

No. 12,255; May 26, 1913.

The object of this invention is to provide means for indicating the quantity of fluid flowing through a pipe by connecting a Venturi tube, orifice, Pitot tube, or the like to a manometer consisting of a reservoir

and a tube which curves upwards with such a curvature that the displacement of the liquid along it is proportional to the flow.




**Hodgson's Indicator for Fluid Flow in Pipes.**

In this illustration, A is the reservoir connected by the pipe B to the upstream end of a Venturi tube or the like and by a U tube C to the curved manometer tube D, the upper end of which is in communication, through the pipe E, with the throat of the Venturi tube. F is a plunger, which can be screwed up and down the fixed screw G by turning the milled head H to adjust the zero-level of the liquid in the reservoir. A sensitive spirit level I is preferably mounted on the instrument. It is also advisable to construct the curved tube so that it is not easily broken—by machining a channel of the correct curvature in a metal plate, and fitting celluloid or glass on either side, so that the liquid in the tube thus formed may be visible. The tube shown, however, is an ordinary glass tube secured in front of the scale plate J.

The method of arriving at the curve of the tube D is explained by the patentee as follows: Set out the curve showing the relation between the rate of flow and the fall in pressure; the rate of flow (say, the number of cubic feet per minute) being set out along the axis of Y and the fall in pressure (say, in inches of mercury) along the axis of X. This curve is a parabola in the case of a Venturi tube; but the method can be applied to cases in which the differential pressure does not vary exactly as the square of the flow. From points on the curve corresponding to equal increments of flow drop ordinates. From the origin draw an inclined line at an angle dependent on the magnification required. From the point where this line meets the first ordinate draw a line to the second ordinate, such that the line between the first and second ordinates is equal in length to the line between the origin and the first ordinate, and so on. The faired-up curve corresponding to these inclined lines is the curve to which the manometer tube should be bent; and the tube should be mounted so that lines parallel to the axis of Y in the diagram are horizontal.

## Atmospheric Gas-Burners and the Art of Gas Lighting.

KEITH, J. & G., of Farringdon Avenue, E.C.

No. 14,490; June 23, 1913. No. 19,206; Aug. 25, 1913.

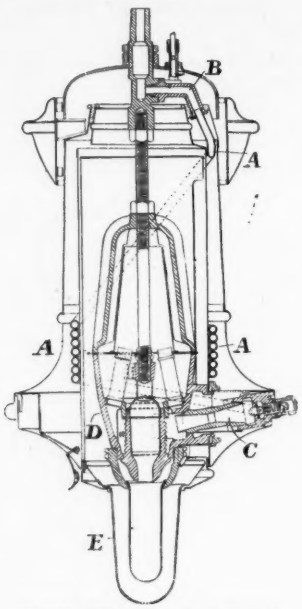
In their specification of this joint application, the patentees remark: In the use of high-pressure inverted incandescent gas-lamps fitted with globes of fused silica (as described in patent No. 1348 of 1912) it has been found that the globes are liable to be discoloured in consequence of the presence in the gas of traces of certain impurities. Of such impurities carbonyl of iron is particularly troublesome, on account of the deposition of iron produced when the volatile carbonyl is heated.

To free the gas from such impurities, the patentees propose to subject it to an attemperated heating action before it reaches the nipple—*i.e.*, before it is joined by the stream of air with which it forms a self-burning mixture, the volume of which is considerably greater than the volume of gas passing through the nipple, rendering it more difficult to separate the impurities after the addition of air than before. That is to say, by preheating the gas in this way they ensure that the iron, &c., will be deposited in the heating apparatus before the gas reaches the nipple. The temperature to which the gas is brought is not so high as to occasion deposit of carbon, but is sufficient to ensure the adequate purification of the gas.

It has already been proposed to utilize the waste heat of a lamp to preheat more or less a supply of gas just prior to its admixture with combustion supporting air, as by passing the gas through a coil receiving heat indirectly from the waste products. Whether or not the preheating resulted, or in the case of untried constructions would result, in the removal of impurities is, they say, problematical. At least, so far as they are aware, purification of the gas was not contemplated, and, indeed, there would be no particular object in purification when not followed by the step of burning the mixture within a closed envelope of material susceptible to the action of such impurities and of such limited dimensions as to be liable to be rapidly obscured.

They show a longitudinal vertical section of a gas-lamp representing one form of apparatus employed in the performance of the invention.

Referring to the drawing, A is a tube constituting the heater for the gas while still unmixed with air. It is connected at its upper end to the gas inlet pipe B and at its lower end to the nipple of the injector tube C. The tube A is in part formed as a coil disposed between the inner and outer casings of the lamp structure and in thermal contact with the inner casing, so that a proportion of the waste heat from the lamp may pass through it to the coil, heating the gas in its passage. "The interior of the tube presents a large surface in relation to the cubical capacity of the tube, so that substantially all the iron contained in the gas as carbonyl of iron will be deposited."




**Keith's Silica Cup Lamp Burner.**

The gas flowing through the nipple induces a current of combustion supporting air to flow through the injector tube C; the gas and induced air being passed through a chamber D, in which they are intimately mixed and highly heated, as described in patent No. 28,360 of 1907, and whence they are led to the interior of the mantle where combustion takes place.

As shown, the mantle is surrounded by a closely-fitting globe E composed of highly refractory material (such as fused silica) which is susceptible to the action of the impurities present in the gas before its passage through the coil.

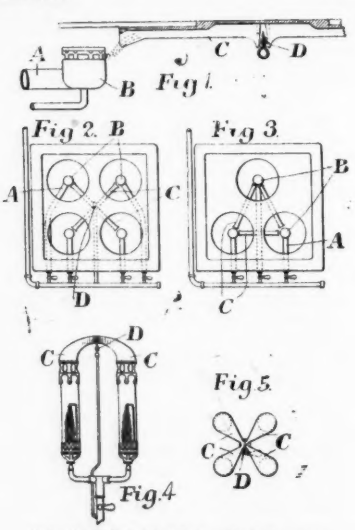
## Pilot-Light for Gas-Burners.

ALDER, F. H., of Zurich.

No. 27,259; Nov. 26, 1913. Convention date, Nov. 27, 1912.

This invention relates to a device intended to enable a gas-flame, or a number of gas-flames, to be ignited by a single pilot flame or other igniting device, as distinguished from devices which require a pilot flame for each gas-flame.

To enable this to be done, a passage (or a series of passages) is arranged between the gas-burners and the pilot-flame by means of which the gas flowing from any unignited burner is conveyed to the pilot-flame, by which it is ignited. Owing to the distance of the pilot-flame from the burner, the patentee remarks, "not only is the latter protected against any injurious influence and any impurity, but this circumstance makes it likewise possible for any desired number of gas-burners to be ignited through such passages by one and the same pilot-flame or the like."




**Alder's Pilot Light for Gas-Burners.**

The form illustrated in figs 1 and 2 relates to a gas cooking stove in which a pilot-flame D is provided, from which passages C lead to the

burners B. These passages have ribs cast in one piece with the stove top and opening downwards. They terminate obliquely over the openings in the burners, in order that a portion of the gas that flows through the pipes A to the burners may be intercepted by the passages and conveyed to the pilot-flame.

In the form of construction shown in fig. 3, the burners B, instead of being connected with the same pilot-flame, are connected with one another through passages C, which open downwards, so that one ignited gas-flame can serve as pilot-flame for the rest.

Figs 4 and 5 show the igniting device in use in connection with a gas-light, the burners of which can be ignited separately or simultaneously by means of a centrally arranged pilot-flame. D in this case is once more the place of ignition; while C indicates the passages which are open below.

### Atmospheric Gas-Burners.

MADGE, W. T., of Arundel Street, Strand, W.C., and WARREN, F., of Forest Gate, E.

Nos. 5028 and 5029; Feb. 26, 1914.

These inventions relate especially to arrangements of atmospheric gas-burners of the type applicable for reducing stereo metal, and having burner mouths according to their patent No. 11,992 of 1913.

According to the first of the present two inventions the burners are arranged in sets of four in a series; each unit or group of the series being controlled by a single tap or cock, so that any number of burners (from one upwards) may be brought into use in each set. They employ a suitable cast base for each burner, which is provided with the usual apertures for the admission of air. The gas inlet consists of a simple straight-through jet screwed into the cast base and having its delivery end standing the requisite distance beyond the air inlet apertures, or else made in two pieces, the upper of which has a tapered bore. The jet is preferably provided with a simple regulator to enable the quantity of gas to be controlled at will—consisting of a simple screw, fitting in the side of the jet, so that its end projects into the bore. Into the top of the base is secured a tube of considerable length, in which the air and gas mixes, and which may be either straight or bent according to the circumstances in which it is employed. The end of this tube is provided with a special delivery nozzle of the type described in the 1913 patent.

## APPLICATIONS FOR LETTERS PATENT.

13,790.—MARSH, R. G., "Gas-meters." June 8.
13,850.—VERSEN, B., "Gas-producers." June 8.
13,862.—DOWN, H. G., "Mantle." June 8.
13,930.—SOC. D'EXPLOITATION DES APPAREILS RATEAU, "Purifying gaseous fluids." June 9.
13,932 —RUSSELL, F. H., and MASON, H., "Controlling the supply of gas to stoves." June 9.
13,934.—DUCKHAM, A M'D., "Carbonizing fuels." June 9.
13,935.—DUCKHAM, A. M'D., "Retorts." June 9.
13,936.—DUCKHAM, A. M'D., "Charging retorts." June 9.
13,937.—DUCKHAM, A. M'D., "Continuous distillation." June 9.
13,964.—M'LEOD, A. M., and W. J. JENKINS AND CO., LTD., "Tell-tale for vertical retorts." June 9.
14,012.—HALL, I., "Atmospheric burners." June 10.
14,056 —SCHOFIELD, W., "Retort stopper." June 11.
14,143.—BÖHRER, K., and SCHELL, E., "Gas-cocks." June 11.
14,230.—DEUTSCHE GASGLÜLICHT AKT.-GES. (AUERGES.). "Gas-tight membrane." June 12.
14,239.—SHARP, A., "Meters." A communication from A. B. Buckley. June 12.
14,240.—MARKEL, K. E., "Bringing liquids and gases or vapours into contact with each other." A communication from Walther Feld, G.m.b.H. June 12.

# PARLIAMENTARY INTELLIGENCE.

## SWANSEA GAS ORDER.

### ALKALI MANUFACTURERS AND THE QUESTION OF LOCUS.

### COURT OF REFEREES.—Tuesday, June 16.

(*Before Mr.* WHITLEY, *Chairman*, *Mr.* E. MOON, K.C., *Speaker's Counsel*, *Mr.* M'LEAN, *Sir* PHIPSON BEALE, *Mr.* MOONEY, *and Mr.* WHYTE).

In this case [the Gas Provisional Orders (No. 3) Confirmation Bill] the United Alkali Manufacturers' Association applied for *locus* against the Swansea Gaslight Company's Order.

Mr. BALFOUR BROWNE, K.C., appeared for the Swansea Gaslight Company; and Mr. J. D. FITZGERALD, K.C., represented the United Alkali Manufacturers' Association.

Mr. FITZGERALD submitted that he was entitled to *locus*, inasmuch as a provision was introduced into an Order relating to this Company in 1912, on the opposition of the present petitioners, and for their protection, which it was now proposed to repeal. In addition to the repeal of the provision referred to, the Company, in the present Order, sought power to "convert and manufacture residual products resulting from the manufacture of gas." The Swansea Order of 1912, which it was proposed to repeal, was, as introduced, in substance the same as this Order. The lands mentioned in the 1912 Order were the same as in the 1914 Order, with a small addition. The 1912 Order was opposed by the Alkali Manufacturers' Association, on the ground that, in connection with its then existing terms, it gave powers for the manufacture of residual products beyond the ordinary powers of gas companies, which interfered improperly in competition with the alkali manufacturers. The case was heard before a Committee, and no objection was taken to the *locus standi*. As a result a clause was inserted limiting the powers of the Swansea Gas Company with regard to the manufacture of residuals. The Company were now proposing to repeal the 1912 Order, and claimed that the manufacturers were not entitled to be heard. It was difficult to understand on what grounds *locus* could be objected to. This question was raised in a number of Bills in 1912, and the *locus* of the alkali manufacturers was only once challenged—viz., in the case of the Annfield Plain Gas Bill—and there the objection was withdrawn before it reached the Court of Referees. The alkali manufacturers got clauses inserted in one form or another in their own interests, and finally the matter went before a Joint Committee of both Houses of Parliament, who made certain recommendations. He did not see how these recommendations could possibly affect the question of *locus standi*. Exactly the same question arose in the South Suburban Gas Bill of this year. In the South Suburban Bill of 1912 the alkali manufacturers obtained a clause almost word for word the same as was inserted in the Swansea Bill of the same session. This year the South Suburban Company came to repeal the clause, and the alkali manufacturers were heard against it. Although they did not succeed in convincing the Committee that the clause should remain, they substituted for it a modified clause, with limitations.

Mr. BALFOUR BROWNE said that in this Order he had no power to deal with residuals at all. The insertion of the clause referred to in the 1912 Order of the Swansea Company was on the basis of precedent, as was seen from the decision given by Lord Clinton, the Chairman of the Committee considering the Order, who announced that the Committee were of the opinion that the Order should proceed, subject to the insertion of the clause submitted by the petitioners. While they did not regard the decisions which had been given on other Bills of a similar character as necessarily governing all cases, they thought that the promoters had failed to show such an essential difference between this case and others that the precedent should not apply.

The CHAIRMAN said it was quite clear that the promoters had come to Parliament asking them to revise their decision of two years ago in the light of the recommendations of the Joint Committee; and therefore it could be well and properly argued before the Court that the petitioners were entitled to be heard.

The *locus* was therefore allowed.

## SKEGNESS GAS BILL.

### HOUSE OF COMMONS COMMITTEE.—Wednesday, June 10.

(*Before Mr.* JAMES MASON, *Chairman*, *Sir* STEPHEN COLLINS, *Mr.* TICKLER, *and Mr.* DORIS.)

This Bill, promoted by the Skegness Gas Company, has already passed the House of Lords [see "JOURNAL," March 31, p. 912].

Counsel for the Bill were Mr. G. J. TALBOT, K.C., and Mr. F. N. KEEN; the only opponent, as in the other House, was the Skegness Urban District Council, represented by Mr. J. D. FITZGERALD, K.C., Mr. WEDDERBURN, K.C., and Mr. G. W. BAILEY.

Mr. TALBOT, in opening, said the Bill proposed to incorporate the present limited Company as a statutory concern, to consolidate the existing capital and raise additional capital, to apply the sliding-scale, adopt a calorific value for testing, and to acquire the freehold of the site upon which the gas-works stand from Lord Scarbrough. All the facts were precisely the same as when the matter was before the other House. Then, the Skegness Council had a separate Bill for the purchase of the Company's undertaking; but this was rejected. So far as the petition against the Bill was concerned, while alleging various matters, the main purport was that the Council should be the gas authority—indeed, since the proceedings in the other House, correspondence had passed between the parties as to whether the matter could be settled. The Company expressed a willingness to agree to all points except purchasing, which the Council placed in the forefront as a *sine quâ non*. Consequently the whole Bill had to be fought again. Counsel reminded the Committee that they could not authorize the Council to purchase the Company's undertaking. The most that could be done would be to express an opinion on the matter—leaving the Council to promote a Bill, if necessary, later on. The Company, however, were emphatically against selling their undertaking. Though there were instances in which gas companies' undertakings had been purchased, this was never sanctioned by Parliament in the absence of some urgent public necessity. No public necessity could be shown in this case, inasmuch as the Company, in twelve years, had reduced the price of gas from 5s. to 3s. 6d. An offer was made to the Council in 1900, when the Company was a non-statutory concern, to sell the undertaking for £12,000—at a time when the capital was £5000. But the offer was rejected. Nothing more was heard of the question of purchase until 1911, when the Company were approached, but replied that they had no desire to sell. Now the suggestion would appear to be that, although the Company had come practically to the end of their capital resources, and needed money urgently for developing their business, they should be kept at a standstill until the Council had obtained the consent of the ratepayers to purchase. Having regard to the fact that the matter of purchase was not really before the Committee, he could not help thinking that the Council might have acquiesced in the decision of the other House when their own Bill for purchase was rejected. The total new capital powers asked for amounted to £52,758, less £1415 already spent on capital account. The sliding-scale, it was suggested, should be applied, with a standard price of 3s. 6d. per 1000 feet and a standard dividend of 5 per cent. The provisions as to the calorific test inserted in the Gas Light and Coke Company's Bill had now been embodied in the Bill.

Mr. *E. J. Brockway*, the Engineer, Manager, and Secretary of the Cleethorpes Gas Company, and Consulting Engineer to the Skegness Gas Company since 1902, was the first witness. In that year the sale was slightly over 8 million cubic feet; but it had increased to nearly 27½ millions last year. This rapid growth had necessitated rather frequent applications for new capital. Having regard to the rate of pro-

gress, he thought it was desirable that the Company should have capital powers which would last for a period of twelve years. The amount of capital now asked for (£52,758) was very reasonable. It included £28,800 for new works and plant, £4941 for mains, £15,000 for services, cookers, meters, and slot fittings, and £2000 for the cost of the present Bill. The works would then have a capacity of 100 million cubic feet per annum, with a maximum make per day of 500,000 cubic feet. The expenditure of £15,000 for cookers, &c., was on the basis of £6 per consumer for 2600 new consumers during the next twelve years. The present average annual consumption was 22,500 cubic feet per consumer. This he had taken at 3½ times more in twelve years time, which was the rate of increase during the past twelve years. With regard to the management of the undertaking during recent years, he agreed that the results had not been so good as might have been obtained; but it was an exaggeration to say that there had been gross mismanagement. What had happened was that a manager who was appointed in 1903 did not get the best results, and he eventually resigned. At the same time the plant was not of the best during this period; and subsequent alterations had considerably improved the working results. Taking the size and situation of the Company, and the price charged, he claimed that the Company had satisfactorily discharged their duties. It was in 1912 that it became evident the management must be changed, although from 1908 or 1909 the working results were bad. Although there had been complaints by certain consumers as to lack of pressure, tests had shown that there was no foundation for them—indeed, since the appointment of a gas examiner he had always reported a pressure of 3 inches, and that the gas was free from sulphuretted hydrogen. The existing Provisional Order only provided for a pressure of 6-10ths in the morning and 8-10ths in the evening. It was true that the Company did not comply with the Provisional Order of 1902 to provide a standard photometer within six months; but the reason for this was that the Council did not appoint an examiner until 1912. The Company had, however, two jet photometers. In 1912, when the Council appointed an examiner, the proper testing-place was provided. As regards price, there was only an increase of 2½d. per 1000 cubic feet to the prepayment consumer. This was the lowest increase he knew of—it being generally 6d. or 8d.; while 10d. was allowed by the Model Bill if no cooker was supplied, and 1s. if a cooker was installed.

Mr. FITZGERALD mentioned to the Committee that the most important question was that of purchase. The other matters were comparatively unimportant if the purchase question was decided in his favour. Therefore he proposed to direct his cross-examination mainly to the matter of purchase.

*Witness*, answering Mr. FITZGERALD, said he knew a list of 140 complaints had been drawn up; but it was canvassed for. Many of the persons, however, complaining of inferior lighting suffered not from the poor quality of the gas, but from poor fittings and badly adjusted burners. A number of questions were put to the effect that as the shareholders were getting their maximum dividend, and admitting bad management, the consumers must have suffered. Special mention was made of the Hunstanton works, where the price is 3s. 3d., as against 3s. 6d. in Skegness, and where the same coal is used. Witness, however, suggested that there may be many circumstances which would account for the difference in price. At the same time he agreed that better management might account for it. He had never denied that the Company had had a bad manager; but the conditions were much better to-day. The amount of gas sold per ton of coal carbonized was next referred to by Counsel, and the fact that 11,000 cubic feet of gas per ton of coal carbonized are sold at Cleethorpes against 9631 feet in 1913 in Skegness. The Hunstanton figure was given as 10,500 feet. It was pointed out by Counsel that there was a worse result under the new manager in 1913 than in 1911 under the old manager, when the figure was 10,250 cubic feet. Witness said the reason for this was on account of the fact that the scrubbers were choked up with tar when the new manager came, and there was not a sound retort in the works—every one had had to be renewed. The best manager in the world could not get the best results out of such plant. At the same time, he (witness) would not agree to there having been gross general mismanagement; he agreed to gross neglect of duty on the part of the manager. The results in the matter of price charged to the consumers showed that there had not been gross general mismanagement. Counsel next referred to the return from residuals. It was agreed that from such a works as Skegness 60 to 65 per cent. of the cost of coal should be recovered on the return for residuals; but the figure had fallen as low as 24 per cent.; and the highest return was 46 per cent. The latter figure, said witness, was a good average for similar sized works throughout the country. Counsel retorted that in 1912 the Auditor refused to pass the accounts without calling the attention of the Board to this matter. As regards unaccounted-for gas, at Cleethorpes the figure was about 3 per cent.; whereas it had been 16 per cent. at Skegness, and now was 9·14 per cent., including the gas used on the works. Witness said the average unaccounted-for gas throughout the country was between 7 and 8 per cent. The actual unaccounted-for gas alone at Skegness last year was only 6·70 per cent. Another indication of good management, said Counsel, was the capital per million, which in the case of Skegness was actually going up instead of going down. Witness said the figure of £1121 at Skegness was due to large capital expenditure recently. His estimates for the future had been based on £750 per million. A decrease in capital expenditure with increased output only held good until the demand overtook the plant capacity. Then the increased expenditure on new plant pushed up the capital expenditure per million; and this was what had happened at Skegness.

A series of questions followed with regard to the action of the Directors in dealing with the late manager, and the repeated representations of the Consulting Engineer that the management was bad. All the time, said Counsel, the shareholders were receiving maximum dividends. Therefore the Directors had not been studying the interests of the consumers. Witness pointed out, however, that this matter, as well as some suggestions that the books of the Company had not been properly kept, had all been remedied. There was no suggestion that the books were inaccurate. They were rather crudely kept, he admitted. Finally, Counsel asked how a shareholder was damaged by a sale, if he got a sufficient sum to enable him to invest in a similar undertaking. As things stood at present, the shareholders were getting this maximum dividend, and could not get any more while the Company remained a maximum-price concern. Therefore, this was an opportune moment for a transfer to the Council. Witness said the question of whether the shareholders would be damaged depended upon the terms of purchase.

At the close of his cross-examination, Counsel handed witness a number of samples of coke, and asked if they had been properly carbonized. Witness said emphatically "No." They had been taken from the mouthpiece of the retort; and even if they had been taken from the Skegness retorts, similar samples could be obtained from the mouthpiece of any horizontal retort in the country.

Mr. FITZGERALD put it that, assuming these were fair samples of the coke produced at Skegness, it would indicate bad management to the extent that the coal was not being properly carbonized.

*Witness* was very reluctant to make any such assumption. He did not believe that the samples came from Skegness.

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### Thursday, June 11.

At the commencement of proceedings this morning,

The CHAIRMAN said: I should like to say that, as regards the finance and general considerations, we feel strongly that the case for the promoters is a good one; but the Bill is assailable—if it is assailable at all—on the grounds that the public interests, or the consumers, are prejudiced. I think that by saying this I shall enable you on both sides possibly to concentrate as much as you can on that one point.

Mr. KEEN, for the promoters, said this intimation would enable him to reduce materially the evidence he would otherwise have called.

Mr. *R. G. Shadbolt*, Resident Engineer, Manager, and Secretary to the Grantham Gas Company, expressed the opinion that the powers sought under the Bill were an imperative necessity having regard to the rate of growth in the district. The Company was fairly well managed, and the works were good.

Mr. FITZGERALD, for the Council, said there was no dispute that the works were good.

*Witness*, continuing, said that during the year 1913 the new manager had hard work in getting over the effects of the previous bad management, and was handicapped very considerably. Therefore, there were special reasons why the utmost results could not be obtained last year, notwithstanding the change of manager. At the same time a concern of this kind must not be judged by comparison with other undertakings, but by comparison with the progress made within itself. On this basis there had been considerable improvement, from which the consumer had benefited, as shown by the reduction in price to 3s. 6d. The ammonia products had been the weak point of the undertaking all through; and the effect of this upon the price of coal was the effect due to what might be termed works mismanagement. On the other hand, the amount of gas per ton of coal carbonized now was very little below the average of similar undertakings. The poorer result last year was due entirely to the reconstruction of the whole twenty-four retorts; but, taken on the whole, he saw no reason why the Company should not be allowed to continue. The 1913 return for residuals, of 11·29d. per 1000 cubic feet, was a very good one, as representing nearly half the cost of coal. Similarly with regard to the leakage at Skegness now, he did not think it was excessive, and, moreover, it was being reduced. The price charged was below the average of a number of similar undertakings in Lincolnshire. There were several cases in which the price was lower; but in Skegness the slot consumers were treated exceptionally favourably. The proportion of slot consumers in Skegness was 63 per cent. The low charge to slot consumers was bound to react upon the general price; the extra amount being 2½d. in Skegness, as against 6d. and 8d. in other towns. He attached importance to the fact that, since the official testing-stations had been installed in 1912, no complaints had been made by the examiner as to the quality, beyond the prosecution following the tests on the first day the apparatus was erected. This prosecution should not have been taken, as the apparatus had not been completely freed from air at the time. The prosecution failed; the Magistrates holding the view that had the tests been continued they would have been satisfactory. He was opposed to transfer in this case on the ground also that the Council were to become the electric lighting authority. To place both the gas and electricity undertaking in the hands of the Council would deprive consumers of the benefit of competition. Further, there were several cases of local authorities having purchased gas companies in which the capital charges were much in excess of the last year of the companies. Three special instances were Morecambe, where the capital charges were now 25·44d. per 1000 cubic feet, against 14·63d.; Shipley, 20·53d., against 11·8d.; and Nantwich, 20·68d., against 6·56d.

In cross-examination by Mr. FITZGERALD, witness maintained that the consumer was no better off under municipal working compared with companies. On the question of a local authority having both gas and electricity undertakings in its own hands, Counsel pointed out that this was quite a common thing. Witness agreed that there were instances, but expressed the opinion that it would be better to have competition. Questions were then put tending to show that the Company were wrong in assuming the same rate of increase in the future as in the past. Witness, however, contended that the rate of progress would be maintained, and added that the Council also held this view.

Mr. *Henry Woodall* (Messrs. Corbet Woodall and Son) confirmed the evidence of the two previous witnesses with regard to the amount of the new capital, and also approved of the suggested conversion. With regard to the adoption of the sliding-scale, in this case the shareholders would receive one-third of any increased profits; the remainder going to the consumers. The shareholders also gave up back-dividends, which amounted to £347, by the adoption of the sliding-scale. If the undertaking was left in the hands of the Company, they could serve the interests of the public satisfactorily. Parliament had refused to grant compulsory purchase of a company by a local authority in some cases, and in others had granted it; but in the latter cases it had always been made clear that it was being done in the interests of the consumers. He regarded it as a means of healthy

competition if the electricity and gas undertakings were carried on by separate parties.

Mr. FITZGERALD, in cross-examination, pointed out that last year the Tottenham and Edmonton Gas Company obtained powers to supply electricity in Wood Green, although they were the gas authority in the district, and expressed the opinion that in small places the two concerns could be carried on more cheaply by one body than separately.

*Witness* admitted this was true to a certain extent. Counsel regarded the figure of increase (10 per cent. for the coming twelve years) put in by witness as too high; but witness maintained that there had been an increase during the past twelve years of more than 10 per cent. He agreed that, if the calorific test was to be adopted, all the conditions contained in the Gas Light and Coke Company's Bill should be imposed.

In answer to a point raised by Mr. KEEN, for the promoters, with regard to the penalties in the calorific clause,

Mr. FITZGERALD said these were not sufficient.

The CHAIRMAN: Were we not agreed that the clause should be the same as in the Gas Light and Coke Company's Bill?

Mr. FITZGERALD said this was so, but the clauses in the Bill at present were not the same.

Continuing, Counsel said that there was less gas per ton of coal carbonized in 1913 than in all the preceding years from 1907 downwards. Witness, however, said that the figure for 1912 was lower than that of 1913—10,633 cubic feet, as against 10,666 feet in 1913. Counsel's figure was 10,797 for 1912—the figure shown in the accounts.

Mr. KEEN, in re-examination, referring to the Tottenham Company taking electricity powers in Wood Green, pointed out that this was done at the wish of the local authority at Wood Green.

Mr. *William Cash* handed in a number of tables dealing with the Company's financial and general position, and expressed the opinion that capital had been raised on very favourable terms for a Company of this sort. The issue of 1907 was raised on the basis of £5 15s. per cent.; the next issue, in 1909, was raised at £5 14s. per cent.; the issue in 1911 at 5½ per cent.; and the last issue, in 1913, at £5 7s. per cent. This showed great care on the part of the Company in raising money as economically as possible; and there was very little in it as compared with the local authority raising capital for 35 years on the basis of 3¾ per cent., because the total charge, including sinking fund, would in that case be £5 6s. per cent. It was these two figures—namely, £5 6s. per cent. and £5 7s. per cent. respectively—which had a bearing on the price of gas. Another thing in favour of the Skegness Company was that it had not piled-up large reserve funds, but had dealt very fairly with consumers; the reserve fund being only £600. Referring to one or two cases of compulsory purchase, special mention was made of Swinton and Mexborough. Here there were serious allegations against the Company in respect of the accounts not being kept in statutory form; there was some 40 per cent. leakage; a very poor make of gas; and actually a drop in the sales of gas—partly due to electrical competition. Furthermore, there had been no alteration in the price for 20 years, and no supply was given to prepayment consumers. The district was a comparatively poor neighbourhood, and should have been dealt with by prepayment meters; while, in addition to all this, the reserve fund was in excess of the amount which the Company were entitled to set aside. There was considerable difference between this case and Skegness, because the complaints against the Skegness Company were really against things which had been removed, and a complaint against an individual and not against the undertaking. In all cases of compulsory purchase there existed at the time some "vice" which was prejudicial to the public interest. Apart from there being no such vice in the case of Skegness, the interests of the public were being further safeguarded by the adoption of the sliding-scale.

Mr. FITZGERALD, in his cross-examination, raised the point that the reserve fund, under the Gas-Works Clauses Act, should have been invested, but this had not been done. It was pointed out in reply that very few companies invested the whole of their reserve funds. If it were done in the present case, there being no existing capital available, the Company would have had to raise further capital and increase their capital charges.

In re-examination, emphasis was laid upon the point that even during the period of the late manager, the price of gas was reduced.

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### Friday, June 12.

Local evidence in favour of the Bill was called this morning.

Mr. *J. H. Canning*, a builder and owner of a theatre, said he had always been satisfied with the gas supply except on one occasion, two years ago, when he had to complain of smell in the theatre. It was found to be due to defective fittings, which the Gas Company put in order. He expressed himself emphatically against the Council purchasing the gas undertaking.

In cross-examination, Mr. WEDDERBURN produced a letter addressed by the witness to the Company in which general complaints were made both as to smell and quality. This letter, witness said, was at the time the late manager was in charge. Answering questions as to the purchase of the gas-works, the purchase of the water-works was referred to. In this case, said witness, Parliament fixed the sum at the cost price of the works *plus* 10 per cent. If the gas-works could be purchased on the same terms, he would have no objection to the transfer. If the purchase, however, was on the basis of arbitration and was fair to the shareholders, it would be a burden to the ratepayers.

In re-examination, witness pointed out that Mr. Stevenson, advising the Council, had put the purchase at 22 years. He had calculated this out at about £55,000, upon which the capital charges would be nearly £3000.

Replying to the CHAIRMAN, witness said he saw no reason why the profits of the Company should not increase with the increase of population.

Mr. *James Connell*, a tailor and proprietor of a boarding house, referred to compliments paid to the quality of the gas in these two establishments. Visitors from Louth and Leicester had said that the light was better than in these two places. The only precaution he took was to keep his fittings in order. There was a complaint in 1912 as to the smell. This was found to be due to a defective purifier valve, which allowed a quantity of unpurified gas to pass into the town mains. This was rectified, and no complaint had been made since. If the Company was to be purchased on the basis of full compensation to the shareholders, it would be a burden on the rates.

Cross-examined: His only interest was that of a ratepayer. There were other things which the Council should take in hand for the improvement of the town before buying the gas undertaking.

Mr. *G. J. Crofts*, a draper, spoke as to a petition being sent round which purported to be asking the Company for a reduction in price. The petition was used, however, for taking the Company to Quarter Sessions. On the question of purchase, he held the same opinions as the previous witnesses.

In answer to the COMMITTEE, witness agreed that he had signed two petitions to the Gas Company without reading them.

Mr. *F. H. Shafto*, an hotel proprietor, said he was quite satisfied with the present gas supply. There had been a great improvement since the new manager came. Even before that, he had no real cause for complaint.

Mr. FITZGERALD elicited the fact, in cross-examination, that witness had agreed to pay £10 towards the cost of the expenses incurred in the actions at Quarter Sessions. Witness said he did this as he was assured that it would result in a considerable reduction in the price of gas. He, like the previous witness, did not read the petition.

Re-examined: He had never been asked to pay the £10.

This closed the local evidence.

Mr. *Maynard Page* (of Messrs. Tweed, Steven, and Co., solicitors, Secretaries to the Company) said the Company had exhausted their capital powers, and additional money was required apart from the reincorporation of the Company. Nothing was heard regarding purchase from 1900, when the Company offered the undertaking for £12,000, until 1911. In August of that year, the Council asked the Company if they would sell, but the Directors would not entertain the proposal. In spite of this, the Council did not oppose the Company's Order of 1902, nor again in 1907. Since 1911, however, there had been considerable friction between the Council and the Company. Witness then detailed the various events already mentioned.

Mr. FITZGERALD cross-examined. His first point was that friction between the Company and the Council was undesirable and could not occur if the Council took over the gas undertaking. A question was raised as to the action of the Company in withdrawing in 1911 the discount previously allowed. The explanation of this was that, as the Council had put the Company to considerable legal expenses, the Directors felt justified in attempting to recover something, inasmuch as the Company in that year were, as a result of this expenditure, unable to pay their full dividend without drawing on the reserve fund. The discount, however, was subsequently allowed again after the Board of Trade inquiry concerning the new testing burner. Counsel referred to the fact that witness acted as Clerk to the Council and as Secretary to the Company, and suggested that he withheld certain information from the Council. Witness, however, said he never disclosed to the Council what went on at the Company's Board meeting, and *vice versâ*. Counsel held that there was no advantage in constituting the Company a parliamentary concern, and that the change would involve stamp duties amounting to £700, which the gas consumers would have to pay.

In re-examination, witness, dealing with the relations between his firm and the Company and Council, pointed out that in 1900 his firm advised the Council not to accept the offer of £12,000. Had the firm acted in their own pecuniary interests, they would have advised the Council to purchase, as the senior partner was a large shareholder. Furthermore, there had never been any complaint against his firm by the Council. Any suggestion that the Company had neglected the consumers was negatived by the fact that 90 per cent. of the householders were supplied.

Mr. *J. H. Salmon*, the Manager of the Skegness Gas Company since November, 1912, said that when he took up the duties he found the plant very much neglected. The retorts were badly carboned up, and the scrubbers were blocked. This threw a lot more work on the purifiers. He had, however, been gradually getting things into a system, and was confident that everything could be maintained in a satisfactory condition. Many of the complaints were due to badly adjusted fittings.

Mr. WEDDERBURN, in cross-examination, suggested that all the things which witness found when he went to the works were matters which Mr. Brockway should have seen on his monthly visits as consulting engineer. Witness, however, thought the state of the retorts would not be seen by Mr. Brockway. Counsel outlined a large number of complaints which he said had been made since Mr. Salmon had been Manager, many of which witness said he knew nothing about. Counsel mentioned complaints by the Borough Surveyor as to opening of roads without notice. These were admitted; but there was an understanding on the matter between witness and the Borough Engineer. He was at the time exceptionally busy; but the proper notices were now handed in.

In answer to the COMMITTEE, witness said there had been certain changes made in the staff since his arrival. There were now no complaints from consumers; the undertaking having been got into a satisfactory condition.

Mr. *G. Dunkley*, the Chairman of the Skegness Gas Company for 16 years, also gave evidence. Since 1911, the Council had put all the obstacles they could in the way of the Company. This had cost them a considerable sum of money, and, in turn, had been reflected upon the consumer. He strongly objected to the undertaking being transferred to the Council, and was convinced that, if left alone, the Directors would be able to do their duty by the town.

Replying to Mr. FITZGERALD, in cross-examination, witness said that, on receipt of the reports from Mr. Brockway that the late manager was not doing as well as he should do, he was called before the Directors and warned. Eventually he was told to resign. Counsel suggested that it was slackness on the part of the Board to allow this bad management to continue so long. Witness, however, replied that

the management could not have been so bad, seeing that the Company were paying 10 per cent. Counsel suggested that the shareholders' interests had come first; whereas if the undertaking was in the hands of the Council the consumers' interests would be the first consideration. Instances were mentioned of bad treatment of consumers, one of which was admitted. This, however, was some time ago.

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**Monday, June 15.**

Evidence was called this morning on behalf of the Skegness Urban District Council.

Mr. *E. H. Stevenson* said that he had inspected the works of the Skegness Gas Company, and they were of sufficient capacity to carry on the undertaking to the time the Council would purchase, if they got power to do so. There was no defect in the works which would prevent the Company supplying gas as cheaply as any other undertaking, and under proper management the results obtained would have been as good as any other concern of the same capacity. In the past the concern had been thoroughly badly managed; and even now it was not managed as well as it ought to be, judging from the accounts for 1913. Mismanagement by the former manager had been admitted; and he had been dismissed. Except by reason of bad management, he did not see why the coal used at Skegness should produce less gas than was produced at Cleethorpes and Hunstanton. He handed in tables dealing with the quantity of gas sold per ton of coal carbonized for a number of years, which proved that the Company were not selling the amount they should have done. The residuals also had not come to that percentage of the cost of the coal which might be expected in a properly-managed works. He had had samples of coke sent up from Skegness, and stated that he had never seen such poor coke before, so far as carbonization was concerned. On analysis it was found that there was nearly 6 per cent. of volatile bituminous matter in the coke, whereas there should have been about 1 per cent., which went to show that the sample was not properly carbonized. The difference between the 1 per cent. and 6 per cent. represented about 1000 cubic feet of gas per ton of coal carbonized. The Company had not given an honest return for the coke made, which had come down in 1912 to only 9 cwt. per ton of coal. Then the sulphate of ammonia produced was also less than it ought to have been. The cost of producing gas in Skegness in 1912 was 2s. 9½d. per 1000 cubic feet, whereas in Hunstanton the cost was 1s. 9½d. Witness handed in a table dealing with the amount of gas, coke, tar, and ammoniacal liquor sold by the Company for a number of years, which also showed that the average result was very much less than what a well-managed undertaking should have produced. He criticized the amount of gas used on the works, which amounted to 3 or 4 per cent. of the output, as against the proportion of 1 to 1½ per cent. used on the works at Hunstanton. There was no reason why there should be such a difference between the two places. The capital expenditure in Skegness was higher in 1913 than in 1907 by 12 per cent. Though bad management had been reported to the Directors of the Company for a number of years, they had done practically nothing to remedy it. The Local Authority were very dissatisfied with the supply of gas. He was convinced that the undertaking would need no such thing as a rate-in-aid if acquired by the Local Authority. With regard to the evidence which had been given by the promoters as to the scrubber not being in a fit state to be used when the new manager came in, as it was choked up with tar, this would cause the ammonia to remain in the gas, and consequently, if left in this state for any period of time, would account for complaints regarding bad smells from the works. During the last six years, since the new retorts had been installed, the Company should have sold gas at 7d. per 1000 cubic feet, or certainly 6d., cheaper than they had done previously. They should also have been in a slightly better position financially than they were at present. If there had been better management, this would have been effected.

In cross-examination by Mr. KEEN, witness said that there should be a large increase in the amount of gas supplied in the future, whether the Company went on with the undertaking or whether the Local Authority acquired it. Counsel pointed out that in most of the large towns in the country the water undertakings were taken over by the local authorities, whereas the gas undertakings were left in the hands of the companies, and suggested that most of the transfers of gas undertakings to local authorities had taken place in the north of the country, near the coalfields, where gas could be sold more cheaply. He also dealt with a large number of cases in which a compulsory purchase clause was refused by Parliament in companies' Bills. There were cases where companies had been transferred to local authorities, which had been unsatisfactory. Witness, however, limited this unsatisfactory working to cases where the undertakings had been acquired by agreement. Counsel criticized the comparisons which had been made by witness with Cleethorpes and Hunstanton, and claimed that they were not good comparisons. With regard to Hunstanton, this undertaking was taken over by a local authority, and therefore was in a better position than the Skegness Company. Referring to the coke which witness had had analyzed, Counsel asked why Mr. Stevenson had not gone fairly and squarely to the Company and obtained the coke straight from them, instead of analyzing that which had been sent for the purpose by the Clerk to the Skegness Council.

Mr. FITZGERALD said the coke had been taken fairly from a quantity supplied by the Gas Company.

Mr. *Stevenson*, continuing under cross-examination, said that the quantity of coke which should be obtained per ton of coal was 12½ to 13 cwt., whereas in 1912 the quantity was only 9 cwt.

Mr. FITZGERALD, in re-examination, dealing with Mr. Keen's point that there were more gas undertakings in the kingdom carried on by companies than by local authorities, said that at one time almost all gas undertakings were in the hands of companies: but there were at present a large number belonging to local authorities. With regard to Counsel's objection to comparisons being made between Cleethorpes, Hunstanton, and Skegness, Mr. Fitzgerald said that there was Cleethorpes, using more coal than Skegness, on the one hand, and Hunstanton, using less coal, on the other; but Skegness was producing much less gas per ton of coal than either of the other two, which pointed to mismanagement on the part of the Skegness Company.

**Tuesday, June 16.**

On resuming proceedings this morning,

Mr. *A. H. Dykes*, who advised the Council last year with regard to the establishment of an electricity undertaking, advocated the carrying on of electricity and gas undertakings together in small towns, as this would tend towards large economies, and consequently towards a reduction of price to consumers for both illuminants. He agreed that competition was a good thing in large towns; but in small towns, where there were two weak undertakings, they began to "cut each others throats," and could not serve the interests of the public well. To illustrate how well the two undertakings could be carried on together, witness mentioned the case of the Bognor Company, which supplied both illuminants. He also referred to the Ascot Gas and Electricity Company, who, in spite of taking up electricity powers, had also increased the sale of gas.

Mr. KEEN, in cross-examination, suggested that if the Companies referred to had been carried on separately they might have been even more successful.

*Witness* replied in the negative. Although, he said, competition made undertakings reduce their prices, they could not reduce them below a certain point.

After obtaining the admission from witness that the Council were seeking to put the generating station of the proposed electricity undertaking next to the gas-works, in order to buy coke from the Gas Company cheaper, owing to the fact that the cost of cartage would be saved, Counsel suggested that the Company might get a better price for their coke outside. Witness, maintained, however, that it would pay the Company to sell cheaper to a neighbour who would take a definite amount every year. Counsel also cross-examined to show that the economies derived by carrying on the gas and electricity undertakings as a joint concern would be very small indeed; but witness stuck to his point that it would be a great advantage.

Mr. *W. B. Keen*, a Chartered Accountant, handed in tables showing the financial position of the Skegness Gas Company for the last seven years, which pointed to bad management. The capital expenditure was very high in 1913; and although the sale of residuals showed a considerable increase, it was still very much below the percentage that should exist compared with the price of coal. The figure of £7 for repairs and maintenance of mains and services for 1913 in the Company's accounts witness regarded as insufficient. With regard to the Company's working during the last four years, there had been deficiencies in each case; the figures being £128 in 1910, £141 in 1911, £352 in 1912, and £172 in 1913. There was also a table showing the adjusted financial results of 1913, after bringing-up the sale of gas per ton of coal carbonized to 10,500 cubic feet, and residuals to 65 per cent. of the cost of coal carbonized, which showed that there should have been a balance available for a reduction of price, after paying the maximum dividend on issued capital, of £608, representing a reduction in the price of gas to consumers of 5·33d. per 1000 cubic feet, if there had been proper management. It was pointed out also that in 1913 a full year's dividend and interest was not paid on the share and loan capital raised in that year, as it would come into full charge in 1914, when increased profits would be available to meet it. On the question of transferring the undertaking to the local authority, witness expressed the opinion that this would be a benefit to the consumers, as there would then be every inducement to the Council to bring down the price of gas.

Mr. KEEN cross-examined on behalf of the Gas Company in order to show that the figures during the last year had improved, and that although before the present manager took charge of the undertaking bad management was admitted, it had not taken place since. With regard to the small figure of £7 being spent in 1913 for the repair and maintenance of mains and services, Counsel pointed out that the figure for this varied very much in most undertakings. Dealing with the deficiency on the working of the undertaking in 1913 of £172, it would be seen that there was the large sum of £456 entered in respect of legal expenses, which was not the case in previous years. Therefore, but for this unusual expense, there would have been a surplus of about £280.

Mr. *Frank H. Jones* (Consulting Gas Engineer) said that the Company had been badly managed in the past, and, in his opinion, was still going on in the same way. In 1913, in which year there was said to be a great improvement, the average quantity of gas sold per ton of coal was smaller than the average for the last five years. The sale of residuals also was no better than previously. The coke was slightly better than in 1912, but still insufficient, and the tar and sulphate were very bad. The balance-sheets for the last few years had shown that the Company had not spent enough on upkeep, depreciation, wear and tear, &c. With regard to the efficiency of the undertaking, the works themselves were pretty good; but the mains were bad and very small, and a great deal would have to be spent on them in the future. Referring to the capital, assuming that the undertaking was not transferred to the Local Authority, the amount of capital, *plus* the loan capital, asked for was about £10,000 more than was necessary for carrying it on for ten or twelve years. The standard price of 3s. 6d. per 1000 cubic feet was high enough; but witness thought that 3s. 4d. would be a fairer figure.

In answer to Mr. G. J. TALBOT, who cross-examined to the effect that it was not usual to fix a standard price below the actual price charged, witness said that if the selling price at the time the Company came to Parliament was agreed to be a reasonable one, this was generally taken as a standard. Mr. Talbot thought it unreasonable that the price should be reduced by 3d.; but witness did not think 3d. was enough. He agreed that the practice was unusual; but with management like this, it was an exceptional case. On the question of the gas and electricity undertakings being carried on jointly by the Council, witness held there would be no loss to the consumers in Skegness by buying the gas undertaking on arbitration terms.

Mr. *Bertram Blount* said he had analyzed the sample of coke from Skegness referred to by Mr. Stevenson, and found that it contained 5·74 per cent. of volatile bituminous matter, 7·16 per cent. of ash, and 1·6 per cent. of moisture. His deduction was that the moisture was very reasonable, and the ash was not abnormal, but the volatile bituminous matter struck him as being excessive; hence his view that the

coke was not properly carbonized. He thought there was a deficit of something like 1100 cubic feet of gas per ton of coal, which would have been available if the coke had been carbonized to the proper point. Taking the make of gas per ton of coal of the average quality as between 10,000 and 12,000 cubic feet, this would make a deficit of 10 per cent. in the total make of gas.

Mr. TALBOT, in cross-examination, suggested that, however good the retorts were, there might be some coke not fully carbonized; but witness did not think this was likely.

Mr. *G. H. Randall* (a member of the Urban District Council) considered that there would be a great saving to the consumers if the gas and electricity undertakings were in the hands of the Council.

Mr. *S. G. Randall* (another member of the Urban District Council) expressed himself in favour of the acquisition of the gas undertaking by the Council.

### Wednesday, June 17.

This morning several local witnesses spoke to the various complaints they had made with regard to the supply of gas; but the general run of their evidence pointed to the fact that, although the supply at the present time is not what it ought to be, there has been a very considerable improvement since the coming of the new manager.

Mr. *R. H. Jenkins* (the Surveyor to the Skegness Urban District Council) said he had had a great deal of trouble with the Gas Company as to the breaking-up of streets and repairing of mains, in that there was too much delay. This also referred to the lighting of the district. The mains and services were, in witness's opinion, very faulty. His predecessor had experienced trouble in this direction. The covering of 2 feet over the mains was, in his opinion, too little. Reference was also made to some gas-meters which had been rejected, and sent to Nottingham to be tested, with the result that they were found to be defective.

Mr. TALBOT, cross-examining, pointed out that the majority of mains all over the country were laid at a depth of 2 feet or less from the surface of the road, and anything more was regarded as exceptional. Witness, however, had never known this to be the case. As to the meters, Counsel said that these were found to be less defective than witness appeared to believe; and he produced the certificate of the expert who tested them. In the Surveyor's report to the Council for 1913, in which it was stated that the relations between them and the Company were not pleasant, although reference was made to the breaking-up of streets, not a word was mentioned about the Gas Company's shortcomings in this respect.

Mr. *H. B. Sutcliffe* (a laundry proprietor in Skegness) said that when the Company installed gas in his premises they charged him a considerable sum for so doing, on the ground that a special pipe had to be laid for this purpose. He had found out since, however, that there was a main within 25 yards of his premises. This being the case, he could compel the Company to supply him. He claimed, therefore, that the Company had extorted money from him under false pretences. He also complained of the bad service of gas to his premises, owing to the fact that he was supplied by a 3-inch pipe, which was fed by a 9-inch pipe, but the connecting pipe between the two was only a 1¼-inch pipe.

Mr. TALBOT, in cross-examination, pointed out that there was not a main within 25 yards of the premises which came within the meaning of the Gas-Works Clauses Act. The Company challenged Mr. Sutcliffe to take proceedings against them, but he had never done so.

Mr. *J. H. Shelley* (a member of the Council) advocated the acquisition of the undertaking by the Council. He had asked a few people in 1906 to sign a document asking the Company to erect a testing-station. The Council had subsequently ordered the Company to do this; but it was not done until 1912.

Mr. TALBOT, cross-examining, obtained the admission from witness that, although he first made application to the Council with regard to this matter in 1906, it was not until 1912 that the Council passed a resolution asking that a testing-station should be erected. The Company was thereupon approached, and the station was erected at once. On the day it was completed the Council made a test, and found the gas to be deficient. They then prosecuted the Company; but the prosecution was dismissed, on the ground that the apparatus had only been fixed on the day the test was taken.

Mr. *J. H. Fairweather* (Gas Examiner to the Skegness Urban District Council) said that he tested the gas on Oct. 11, 1912, at 3 p.m., and found the quality of the gas to be 9·6 candles—the standard being 14 candles. This, however, was not a legitimate test. He returned at 8 p.m., and made a number of tests; the average result being 12·2 candles. A further test was made on Feb. 4, 1913; the quality being 13·8 candles. Another test was made on March 17, 1913; and the quality was found to be 16·6 candles. On Aug. 19, also, the gas was found to be as high as 16 candles; but this was mostly due to the use of the new test-burner—the "Metropolitan" argand No. 2. The high quality on March 17 could not have been effected by fair means.

Mr. TALBOT, in cross-examination, said the Company denied having used benzol on the works.

*Witness* said he considered this a deliberate falsehood.

Mr. FITZGERALD, in re-examination, said it would only need a small quantity of benzol to have effected such a rise in the quality of the gas. In reference to the test on Aug. 19, when 16 candles was obtained by the new burner, this would only have represented 14 candles if the old one had been used.

### Thursday, June 18.

The proceedings were concluded to-day.

Mr. *F. Acton* spoke as to the transfer of the Company's undertaking in Nottingham to the Corporation by agreement, which had brought about a great improvement in the supply of gas, and a reduction in the charge for gas. Since the transfer, the undertaking has contributed over £100,000 towards the relief of rates.

Mr. KEEN pointed out that the comparison between Nottingham and the Skegness Company was not a fair one.

Mr. *W. H. Bridges* (an architect and late Surveyor to the Skegness Urban District Council) gave evidence as to the loss and inconvenience to his clients in consequence of the unsatisfactory working of the Gas Company. He also referred to difficulties encountered in his capacity as Surveyor to the Council.

Mr. *V. A. Tippet* (Assistant Clerk to the Council), on the question of the coke which had been analyzed by Mr. Blount, said he had obtained this from a heap which Mr. Randall (a member of the Council had purchased from the Gas Company.

Mr. WEDDERBURN, addressing the Committee on behalf of the Council, referred to the public opinion in Skegness, which was in favour of the acquisition of the gas undertaking by the Council. There were fifteen councillors, of whom nine voted for the acquisition, two could not vote on account of their having an interest in the Company, and four were afraid of the expense which would be involved by a parliamentary fight, which would, in the event of failure, fall upon the rates for a single year. In the event of the Council securing a purchase clause, however, these expenses, together with those incurred in 1915 in connection with the promotion of the purchase Bill, and by the arbitration proceedings, would be spread over a period of five years. The shareholders of the Company were now receiving their maximum dividends and would lose nothing by the transfer, as they would get the full value of their shares. It had been stated by Mr. Dunkley, the Chairman of the Company, speaking of the late Manager, that bad management could not have been going on, owing to the fact that the shareholders were receiving 10 per cent. dividends. This went to show that so long as the shareholders got as much as they could, they did not care what happened. Mr. Dunkley had also said that his policy was "shareholders first, and consumers afterwards," and, therefore, in Counsel's opinion, the consumers were entitled to proper protection by the local authority. The inaction of the Directors was also commented upon, inasmuch as complaints had been made to them by various people of the unworthiness of the late Manager; but a long time had elapsed before any action was taken. Mr. Salmon, the present Manager, was not very satisfactory, as was shown by the evidence given by Mr. Jenkins, the Council's Surveyor. Counsel appealed to the Committee to render impossible a repetition in the future of what has occurred in the past. The petitioners had established mismanagement in the past, which was still continuing, and the desire of the consumers and the ratepayers to have the undertaking in the hands of the Council, and had shown that no harm would come to the shareholders. Therefore they were entitled to be free from a Company with whom they had had trouble in the past, and would be still likely to have in the future.

Mr. TALBOT, replying on behalf of the Company, dealing with the petition, pointed out that this started by alleging that the Bill would injuriously affect the Council. In support of the main allegation—that the Bill would inflict injury on the Local Authority—no case had been made at all. On the general question as to the transfer of the undertaking, it did not follow that because the Council were constituted the gas authority the supply of gas would improve. In this connection reference was made to the consolidation of all the Water Companies in London to one large concern. The result was that the price of water went up, and the ratepayers had to pay a rate-in-aid. Coming back to Skegness, Counsel pointed out that in 1901, at the request of the Council, the Gas Company quoted the price of £12,000 for their undertaking. But the matter was dropped at this point; and in spite of the fact that the ratepayers were supposed to have had a grievance against the Company, nothing was done up to 1911, although the Company were in Parliament twice during this period—in 1902 and 1907. The Company, however, now refused to sell, but had estimated the value of their undertaking at between £50,000 and £60,000. This was made up as follows: The Company being a maximum dividend concern, they were bought up on the basis of a certain number of years' purchase; and the average number of years being 25, this would amount to £39,125. They were also entitled to some consideration on account of the undertaking being sold compulsorily; and assuming this to be 10 per cent. of the last amount, the sum would be £3912; the loan capital would amount to £6500; and assuming the parliamentary and arbitration costs to be £10,000, the total would come to £59,537. So that the value estimated was not by any means unfair. This did not include compensation to officials, nor did it take into account the fact that the Company had provided works which were calculated to carry on the undertaking for a number of years. The Council were establishing an electricity undertaking which would be a direct means of competition with the Company, and afforded a great stimulus in the way of encouraging them to do their very best for the customers. The Company were now, in fact, improving considerably, as was admitted by witnesses called on behalf of the Council. The evidence of Mr. Tippet, as to the coke which had been analyzed being taken from a heap on Mr. Randall's premises, was also emphasized. The sample, Counsel contended, should have been applied for at the gas-works. Finally, it was pointed out that the Committee were not only asked to say that the Company were incapable of carrying on their undertaking satisfactorily in the future, but that the Council should have power to do this. The way in which the Council would manage the gas-works, however, seemed to have been entirely overlooked, and Counsel claimed that the members of the Urban District Council knew nothing about the matter.

After deliberating in private,

The CHAIRMAN said the Committee had found that the preamble was proved, provided that if the Local Authority bring forward a Bill to purchase in the next session of Parliament the Company should not oppose, except on detail.

[The consideration of clauses will be entered upon to-day (Tuesday). The purchase clause, it is hoped by the parties, will be agreed on.]

**Fylde Water-Works Profits.**—The Fylde Water-Works, jointly owned by Blackpool, Fleetwood, Lytham, and St. Annes, made a gross profit during last year of £56,000—an increase of nearly £1000. In the twelve months £50,000 was spent on capital account; one-half of this sum being on the new reservoir at Grisedale Lea. It is stated in the annual report that, owing to the unavoidable delay in the construction of this reservoir, the water storage is not commensurate with the rapid increase of consumption in a dry season.

# LEGAL INTELLIGENCE.

## ANOTHER CASE OF PREFERENTIAL CHARGES.

In the Chancery Division of the High Court of Justice last Friday, Mr. Justice SARGANT had before him a motion by the plaintiffs in the action of *Attorney-General* (*at the Relation of the Ilford Gas Company*) *v. Ilford Urban District Council*.

Mr. MARK ROMER, K.C. (with him Mr. TYLDESLEY JONES), said the case was similar to one tried recently by his Lordship (*Attorney-General v. Long Eaton Gas Company*);* but in this case, besides asking for an injunction to restrain the defendants from giving preferential treatment to one consumer over another, they also sought to restrain them spending the ratepayers' money in supplying electrical fittings or apparatus. This case was even stronger than the provious one, because here there was no question of supplying power—the differentiation was solely between those who took a whole and those who took a partial supply.

Mr. MARTELLI, K.C., suggested that the case was one for trial; but if the plaintiffs wished to go on with the motion, he desired time to answer the evidence.

After some discussion, it was agreed that the motion should stand over for a fortnight; the defendants undertaking in the meantime to spend no more money in the purchase of electrical fittings or apparatus, and to enter into no new contracts for the supply, sale, or letting out on hire of such fittings and apparatus.

His LORDSHIP directed the motion to stand over accordingly.

## AN ELECTRICITY GENERATING STATION NUISANCE.

### Edwards v. Brixham Gas Company.

This action was mentioned to Mr. Justice Neville in the Chancery Division last Tuesday, when the defendants applied for a further extension of the suspension of the injunction granted against them in December last. [See "JOURNAL" Dec. 23, 1913, p. 957.]

Mr. PALMER, who made the application, reminded his Lordship that, holding that certain recently installed machinery caused an actionable nuisance, he granted the plaintiff an injunction, but suspended its operation for three months to enable the Company to take steps to abate the nuisance. In March last, in his Lordship's absence, Mr. Justice Astbury had extended that suspension for a further three months [see "JOURNAL," March 31, p. 921], and the defendants were now moving for further time. They had served the plaintiff with notice of the motion. The evidence, however, was not complete, and the motion could not be heard before the stay granted by Mr. Justice Astbury expired. His present application therefore was that his Lordship should extend Mr. Justice Astbury's order for a fortnight.

Mr. PETERSON, K.C., on behalf of the plaintiff, said that he should strenuously oppose the motion; but if the evidence was not ready, he had no objection to its standing over for a fortnight.

Mr. PALMER: With the stay continued in the meantime?

Mr. PETERSON said he would not object to this.

His LORDSHIP accordingly directed the defendants' motion to stand for a fortnight, and extended the suspension of the injunction during that period.

## DISCS FOR PENNIES AT MANCHESTER.

As illustrating the spread of the "discs for pennies" movement in Manchester, our correspondent has forwarded a number of tin discs cut as nearly as possible to the width of a penny, together with two common hairpins bent to a similar approximate width, which were found in the cash-box of an automatic sweetmeat machine at the Alexandra Park station of the Great Central Railway Company.

Detective Butler said that in consequence of complaints received by the Detective Department, he was detailed for special duty on prepayment machines of all kinds. He saw the two defendants (Frederick Derry and Arthur Penny) in the vicinity of the station. Derry went to the machine, and, as he returned, Penny asked him whether he had "managed it." He replied in the negative, but went again and placed something else in the aperture and pulled the drawer which contained wax-vestas. Both defendants afterwards left the station, and the drawer was immediately opened—two hairpins, twisted to the width of a penny, being found in the machine.

At the request of the Magistrates, the tin discs and wire pins were handed up for inspection. The Chairman remarked that he did not think they were heavy enough; whereupon a witness who was in Court on behalf of the prosecution said the essential point was the width and not the weight of the penny. More than 200 cases had occurred on the Alexandra Park station during the past month, representing goods worth 19s. In some cases, however, the disc would become fixed in the wheel-cog, and enable any number of packages to be taken out by means of a single wire hairpin such as those produced.

Both defendants pleaded guilty, and were cautioned and discharged by the Chairman of the Bench (Mr. T. Johnston) on account of their youth and hitherto unblemished record.

The representative of the prosecutors—the Automatic Machine Company, Limited, of Lower Broughton, Manchester, mentioned that, as a rule, the Company relied, in connection with the disc and larceny problem, on the Judges' decision quoted in *Regina* v. *Hinds* in the "Justice of the Peace" for January, 1888 [Vol. LII., p. 24, Crown Cases Reserved]. Chief Justice Coleridge held that it was larceny; and Justices Pollock, Stephens, Mathew, and Wills concurred.

* *See ante*, pp. 51, 130, 511.

# MISCELLANEOUS NEWS.

## LONDON COUNTY COUNCIL AND THE GAS LIGHT AND COKE COMPANY'S BILL.

### The Calorific and Illuminating Power Question.

At the Meeting of the London County Council to-day, the Parliamentary Committee will present the following report on their proceedings in regard to the Bill of the Gas Light and Coke Company of the present session.

The Gas Light and Coke Company Bill, as introduced, proposed to lower the existing standard of calorific power to which the Company's gas is now subject, and to abolish the existing standard of illuminating power of 14 candles. The proposed change in the calorific standard was from the equivalent in calories of about 544 B.Th.U., with a penalty where the gas fell below 498 units, to 540 B.Th.U., with a penalty at 475 units. United opposition to the proposals was offered on behalf of the Council and a number of other authorites before a Select Committee of the House of Lords. In the result, the Committee decided that the test for illuminating power should be continued for the purposes of information only, without penalties for any deficiencies; that no good ground had been shown for lowering the calorific standard; that the maximum and minimum standards of calorific power proposed in the Bill should not be sanctioned, but that a minimum standard of 540 B.Th.U. should be inserted in the Bill, subject to penalties if the gas gave a calorific value of $7\frac{1}{2}$ per cent. below that figure (or 499·5 B.Th.U.). In the event of a deficiency from the standard, the average of testings on one day only is to be taken as the calorific value, and not the average of testings on three consecutive days, as is now the case under the existing law. Having regard to the decision of the Select Committee, we decided, with the concurrence of the Public Control Committee, to take no further action in regard to the provisions for testing for calorific power. The promoters have agreed to insert a clause in the Bill similar to a provision in the Company's Act of 1909 requiring them, on application by consumers, to provide and fix, free of charge, burners suitable for the consumption of the Company's gas. The clause will have effect for two years from Jan 1, 1915. It was not necessary to deposit a petition against the Bill in the House of Commons.

## THE GERMAN GASHOLDER FOR TOTTENHAM.

### From the "Tottenham Weekly Herald."

Some comment has been evoked in the Press in various parts of the country on the fact that the Tottenham District Light, Heat, and Power Company had accepted the tender of a German engineering firm for the construction of a new gasholder for the Company which is to have a capacity of $6\frac{3}{4}$ million cubic feet; and a contract for its supply and erection has been entered into with one of the largest constructional engineering firms in Germany. It is understood that the cost will be somewhere between £30,000 and £40,000.

Referring to the placing of this contract abroad, the "Yorkshire Post" remarks: "In inviting tenders the Company let it be known that the order would be placed with the firm submitting the most favourable quotation, irrespective of country of origin; and that American and German firms were being asked to quote. It was hoped that British makers would rise to the occasion, and secure the order; but when the tenders came in it transpired that the lowest British tender was 12 per cent. above that of the Germans, and in face of such a difference (amounting to nearly £4000) the Company felt bound to place the order with the German firm. Since our British makers do a very steady business in the erection of gasholders on the Continent, it seems incomprehensible to the ordinary man how a Continental firm can manage to beat us on our own doorstep. Doubtless reasons exist, but they are not forthcoming. It is vaguely hinted that the prices quoted by the home firms for the home trade are not strictly competitive prices. Collusion is suggested. Perhaps the home makers will repudiate any such idea. But it is well known that the German syndicates pursue regularly the policy of selling dear at home and cheap abroad; and it is equally well known that some British makers of certain lines of engineering goods will accept prices for shipping orders which they would not look at for the home trade. And thus from time to time we get the curious spectacle of country A being undersold in its own territory by country B; while country B undersells country A in its own territory with virtually the same article—the net effect being equal to an overcharge of perhaps 10 per cent. to the people of both communities. In the case under notice it is announced that, though the steel and some of the skilled labour will be German, the cast iron and the bulk of the labour employed will be British. It is noteworthy that the American tenders were highest of all, though the lowest American came within 4 per cent. of the highest British."

The "Tottenham Herald" concludes its article by saying: "We have made inquiries, and have been informed that there is not the slightest doubt that a very strong 'ring' exists among the British makers of gasholders, who number about twelve. As in all such combinations, every effort is made to maintain secrecy, but without success. What happens is that when any competitive job comes out, the Association convene a meeting and settle how much 'fine' is to be put on the job, to be divided among those who are not successful tenderers, and who may have included in each of their tenders an amount of some £2000 or £3000, so as to ensure to each firm a substantial profit, though it does not secure the contract. In the event of one of them being successful, it naturally follows that the enhanced price at which the contract is given in such circumstances has to come out

of the pockets of both shareholders and consumers, in the shape of less dividend or the higher price of gas. The aim of the Tottenham Company has been, as our readers are aware, to lower the price of gas as much as possible; and for many successive years now reductions have taken place, so that the district is being supplied at almost the lowest price in the country. This policy makes not only for the prosperity of the Company, but for the advantage of the consumer. The gas industry now is in a flourishing state all over England; and it is said the firms in question are determined to share in the prosperity in the way they have arranged among themselves. It was this knowledge that led the Directors of the Tottenham Company to invite foreign tendering, and so help to break the ring, which they have done, as stated, to the extent of saving 12 per cent. on the tender accepted. As a matter of fact, it is known that as soon as the tenders were invited from abroad, the English combination took steps to induce the German firms to join them; but in that they failed. Had the lowest tender of an English firm been accepted, it is estimated that it would have entailed a perpetual charge on the consumers of about £200 a year. This is the first time the Company have adopted the course they have done—all their existing holders being of English make, though German steel was used for the construction of the last one."

## BIRMINGHAM GAS AND WATER ACCOUNTS.

We have received from Mr. Thomas H. Clare, the City Treasurer, a copy of the City of Birmingham financial "Blue-Book" for the year 1913-14. This is accompanied by an epitome, from which the following figures relating to the gas and water accounts have been taken.

As to the Gas Department, the revenue account shows a balance of income in excess of expenditure of £186,270 for 1913-14, carried to profit and loss account. After providing for annuities, interest, and redemption of debt, the balance of the profit and loss account was £65,584. The amount of capital expended during the year was £145,874; and the value of buildings and plant abandoned, &c., was £15,451. The total expenditure on capital account to March 31 was £2,581,947. The amount of the reserve fund provided out of revenue, with accumulations, was £100,000; while the gross total of loans negotiated, including annuities, was £2,938,949. The sum provided from revenue for the redemption of debt in 1913-14 was £51,460; and the gross amount provided for redemption of debt to the end of the year was £1,128,992. The balance of loans remaining to be provided for was £1,809,957.

The revenue account of the Water Departmennt for 1913-14 shows a balance of income in excess of expenditure of £221,733, carried to profit and loss account. The profit and loss account shows a loss of £80,467, which has been provided for as follows: Contribution from the borough rate, £65,000; transfer from capital under section 22 of the Birmingham Corporation Water-Works Act, 1902, £80; balance carried forward, £15,387. The amount of capital expended during the year under the 1892 Act was £19,743. The total expenditure on capital account to March 31 under the 1875 and 1879 Acts was £2,097,860; and under the Act of 1892, £6,274,739. The gross amount of loans negotiated, including annuities, under the 1875 and 1879 Acts, was £2,097,860; and under the 1892 Act, £6,297,500. The amount provided from revenue for redemption of debt during the year, under the 1875 and 1879 Acts, was £19,166; and under the 1892 Act, £15,020. The gross amount provided for redemption of debt to the end of 1913-14, under the 1875 and 1879 Acts and the 1892 Act, was £358,244. The balance of loans to be provided for, under the 1875 and 1879 Acts, was £1,809,675; and under the 1892 Act, £6,227,441.

## FATAL ACCIDENT AT A GAS-WORKS.

### An Ipswich Inquiry.

At the Ipswich Town Hall last Wednesday, a Coroner's inquiry was concluded relative to the death of John C. Smith, an employee of the Ipswich Gas Company. The inquest had been adjourned in order that the Jury might visit the scene of the accident, and hear further evidence. Witnesses stated that a shout was heard on the previous Friday, and deceased was found in a crouching position between some stairs and the retort-house wall. An iron bar, on which were blood and hair, was found at the foot of the stairs. The hospital doctor said that in all probability the injury to deceased's skull was caused by the fall of the iron bar.

Mr. *C. E. Wright*, Works Manager, said that the building containing the vertical retorts (in which the accident happened) had only recently been erected. The work was completed on April 29, when gas was first produced. The retort-house was still under the supervision of the contractors. By the terms of the contract, a foreman was present day and night. In the presence of a juryman, the bar had fallen twice. It was necessary to have a space between the furnace floor and the wall, to allow for expansion, and also for ventilation. He was not responsible for the floor being in the condition in which it was. From what had happened, he now thought that it would have been better to have had wiring as a protection. It had not occurred to him before that the space left in this manner was dangerous. It suggested itself to him that the bar had been standing against the wall in a perpendicular position. There was not much vibration; but if the bar had been imperfectly placed, it might have been enough to have made it fall. There was no instruction issued to the men for placing the bars. They had always previously been accustomed to working on a solid floor. In future houses a wire grating along the space would be a very good idea; and the suggestion would be made to the contractors.


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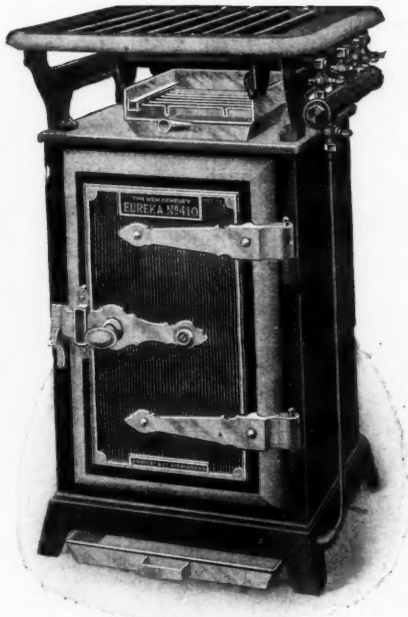


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Deceased was a very popular man; and there was no suggestion that the bar could have been deliberately thrown down.

*John Newson*, stoker, said that he had been using the bar in question at the front of the furnace. After doing so, he put it against the wall. He heard a noise while he was at work, and looked round, and shouted: "Look out below," because he heard something fall. He did not know till he came down that it was his bar. The bar must have hit the wall and rebounded. If it had gone straight down, it would not have touched the stairs.

The CORONER; Did it occur to you that the space was dangerous?

*Witness:* Yes. I have spoken as to the danger consequent on the space being unprotected between the floor and the wall to the foremen several times. Deceased and himself were the best of friends; and he was very sorry that such a thing should have happened.

Mr. COOPER (Home Office Inspector of Factories): You say you spoke to the foremen. Is that the only mode of communication to the Company?

*Witness:* Yes; these are the proper people.

You have not a Safety Committee on the works?—I do not think so.

Mr. COOPER said that he had inspected the retort-house (No. 2), including the furnace-floor and the staircase where the man was found. The only thing he had to comment on was the space between the floor and the outer wall. His impression was that this was distinctly a source of danger which might have been foreseen and quite easily prevented. The platform of the retort-house was peculiar of its kind. He suggested that a grating ought to be at once provided. The evidence, he thought, was quite conclusive that the bar was placed perpendicularly against the wall. He did not think that the particular building had been inspected by the local Factory Inspector. There had been no direct infringement of the Factory and Workshop Acts.

The CORONER, in summing up, said there could be no doubt that death was due to the iron bar falling on deceased. Newson admitted that the bar was his; and he did not deny that he was the man who shouted out. If the Jury thought that Newson had acted culpably, they must say so. They must remember that there were no regulations for the retort-house, and that this was a new system. He pointed out that Newson had recognized the danger of the place. It was one of the prerogatives of the Court that they could make a presentment; but this was hardly necessary, as no doubt the Manager of the works would take the necessary precaution. There was not the slightest suggestion that there was any bad blood between Newson and deceased. If Newson had thrown the bar down, he would have been responsible; but there was no evidence to this effect. As the Inspector had told them, there had been no direct infringement of the Act.

The Jury found that the death of deceased was perfectly accidental, and had been caused by the fall of an iron bar. The Foreman said that the Jury attributed no culpable negligence to anybody. They added, in a rider, that a grating or some sort of protection should be provided. The Company were no doubt doing all they could to have the matter remedied; but it should not have gone on so long. The Jury were also surprised that the building did not seem to have been inspected by one of the Factory Inspectors.

Mr. S. A. NOTCUTT, on behalf of the Directors, expressed their great regret at the distressing accident. The representations of the Jury would receive very careful consideration.

Mr. *Frank Prentice*, the Engineer, said it was only fair to state that Mr. Boggis Rolfe, the Factory Inspector, had visited the place a few months ago. The building was then in course of erection; and he intimated that he would prefer to see it when completed. He was then taken ill; and he was now seriously unwell. Another Inspector had been appointed to do the work while Mr. Boggis Rolfe was ill.

## DAMAGE TO GAS-PIPES THROUGH MINERAL WORKINGS.

The question of the damage done by mineral workings to valuable properties on the surface and to gas, water, and sewage pipes owned by the local Town Council, has again been raised in a somewhat acute form in Motherwell. The agitation has been revived, to some extent, by an announcement made by the Wishaw Coal Company that they will shortly remove certain of the stoops of coal which were left in some years ago for the protection of property on the Coursington Estate. This intimation has engendered the fear that many buildings will be jeopardized; and, as a result, a largely attended meeting of the feuars on the Coursington and Dalzell Estates of Lord Hamilton, the Superior, has lately been held. Details were given of the extraordinary wreckage which had already resulted to existing houses, public works and buildings, and institutions within the burgh. Mr. J. K. Murray, Solicitor, stated that in the annual report of the Gas Company, issued about a year ago, it was represented that 14 million cubic feet of gas had been lost in consequence of the mineral workings crushing the pipe-joints. This quantity of gas would have added £1750 to the revenue of the Company for one year alone. Moreover, he had been informed by an official of the Company that, beyond this actual loss, a considerable sum was annually expended in keeping the pipes in order. Indeed, but for the damage done by the underground workings, this outlay would not have been necessary. He had further been informed that one pipe had been so severely pulverized that a practical man could not have told what it really was unless he had been made aware of the fact that it originally had been a gas-pipe. The gas-works had now been taken over by the Town Council; and if this constant damage to the pipes was to continue, it would involve the community in very serious loss indeed. In the result, a representative deputation was appointed to wait upon Lord Hamilton and confer with him in regard to the situation.

The Sedgley Urban District Council have decided that a Committee, with the Gas Manager and the Clerk, be authorized to engage an expert to report upon the supply of gas, and generally upon matters appertaining to the efficient working of the gas undertaking.


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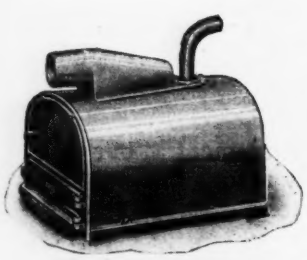

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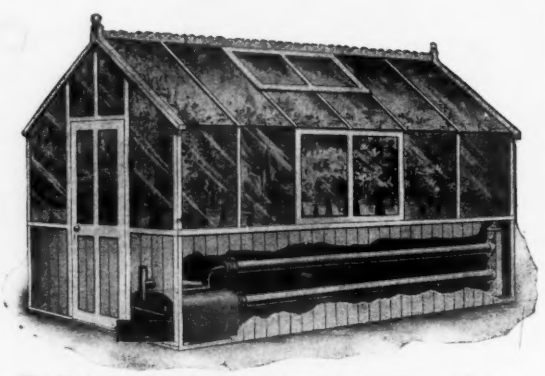

The "Daisy" fixed inside the Greenhouse showing Flue and Swingout Lighting Door outside and Circulating Pipes and Expansion Box inside.

## MUNICIPAL GAS AND ELECTRICITY UNDERTAKINGS.

### Reply to Mr. J. G. Newbigging's Suggestion for Combined Control.

At the Nineteenth Annual Convention of the Municipal Electrical Association, which opened in Birmingham last Tuesday, the President (Mr. R. A. Chattock), in the course of his address, referred to the observations made by Mr. J. G. Newbigging on the combined control of municipal gas and electricity undertakings, on the occasion of the annual meeting of the Manchester District Institution of Gas Engineers early in the year.

Mr. Chattock said Mr. Newbigging suggested a combined control for municipal gas and electricity undertakings. He was glad to have the opportunity of joining issue with him at once. He was of the opinion that the single control of gas and electricity undertakings would have exactly the opposite effect to that outlined by Mr. Newbigging. It would mean the total suppression of competition, and would create what he considered would be fatal to the interests of the consumer—namely, collusion. Instead of tending to foster keen rivalry between the two departments, it would effectually destroy that desire among the staff to improve upon previous records that was such an immense factor in the success of these public supply undertakings. Fair competition must always have a stimulating effect on industrial concerns, and to stifle this would be to deprive the ratepayer of the only real guarantee that he had for the most economical administration of both departments.

The charge that prices for current were sometimes cut down to an unjustifiable figure to secure business could not be substantiated. The sale of gas was largely controlled by the amount the undertaking could obtain for its bye-products. This sum was frequently greater than the gross profits earned during the year. The Electricity Department had no bye-products to sell except the useful employment during the hours of small demand of the generating plant and underground distributing mains, which had been purchased to supply the maximum load demanded during the winter months—that was to say, cheap current with a high load factor; and low quotations for current of high load factor were perfectly justifiable under these conditions. They were not given with the sole object of securing business, but to reduce the average cost of giving the supply, to the benefit of the whole of the consumers.

He maintained that it would be impossible for one manager and one committee to work both departments in the interests of both classes of consumers. A man must become biased to a certain extent in favour of one or other of the branches of the supply, and it would be practically impossible for him to give an unbiased recommendation to his committee on a point involving, for instance, the development of some new area, as to whether this should be carried out by gas or electricity. Consumers would resent being told that they could only have one or the other; and such a policy would undoubtedly have the effect of driving manufacturers and others away from the city, while it was more than likely that the Board of Trade would be inclined to admit outside competition from power companies if they found that the statutory obligations for giving a supply were not being properly carried out.

To his mind there was no evidence whatever that the existing methods of single control of both gas and electricity undertakings had been unsuccessful. There was a field for both of them, as was shown by the increased outputs of both that were recorded year by year, and until such evidence was available, single control should not be considered. If centralization ever came—and it would be greatly to the advantage of the users that it should—it was obvious that it would be quite impossible to arrange for single control of two industries, one of which was purely local and limited to comparatively small and isolated areas, while the other was national and capable of being applied over the whole of Great Britain as one concrete system of supply.

## DUBLIN WATER SUPPLY.

Sir Charles Cameron, C.B., the Medical Superintendent Officer of Health for Dublin, in the course of a "Brief History of Municipal Public Health Administration in Dublin," reviews the development of the water supply of the Irish Metropolis. He recalls that formerly the water used by the citizens and people on the outskirts of the city was obtained from the Rivers Liffey, Dodder, Poddle, and Swan, and also from wells, and that after the two canals—the Grand and the Royal—were formed, supplies were obtained from them; the rivers degenerating into sewers. It was in 1859 that Sir John Gray and Alderman Kinahan were requested by a Corporation Committee to select an engineer to advise as to the best way of obtaining an abundant supply of pure water; and Sir Charles pays tribute to the exertions, as well as to the sagacity, of Sir John Gray in securing for Dublin one of the finest supplies in Europe. It was determined that the water should come from the River Vartry (co. Wicklow), which was impounded near Roundwood, about 22 miles from the city, and converted into a lake covering 418 acres and capable of holding 2400 million gallons—equal to a seven months' supply. The works were commenced in 1863, and were not completed until 1868. Since the latter year there has been a steady demand for the Vartry water by districts outside the city; and it is mentioned that when works now in progress are completed such an abundant supply will be afforded that it is likely to be used in part as a mechanical force. Some 17 million gallons are now received daily. The quality of the Vartry water has been questioned; but, according to Professor Percy F. Frankland, F.R.S., it complies with the most stringent demands of modern science. The total capital expenditure on the undertaking has been £927,408. About £70,000 will be required to complete the new reservoir; and when this has been done, Sir Charles predicts "there can never then be a water famine in Dublin."

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## NOTES FROM SCOTLAND.

**From Our Own Correspondents.**

*Saturday.*

The Glasgow Corporation Electricity Department are finding that with the introduction of "flame arc" lamps, which give more light with the use of less current, the rates for public lighting are decreasing. The increase, which amounts to £32,735 over last year, has been due entirely to sales to private consumers. The average price at which current has been supplied to consumers works out at the low figure of 1·156d. per unit. An accident occurred through the striking of the casing of the wires for electric lighting, which caused an explosion of gas in the street, and injured the workmen employed in digging the hole. The remark in this column recently as to the misnaming of explosions, has been exemplified in a well-known Glasgow paper, which describes this occurrence as an "electricity explosion in Glasgow."

The Dundee Gas Commissioners have fixed the price of gas at the same rate as for last year—namely, 2s. 2d. per 1000 cubic feet; and it is estimated that the revenue will be £158,126. The Auditor has again directed attention, in his docket to the accounts of the Gas Department, to the fact that the contributions from gas revenue made to the "Common Good" were illegal. If, however, they were looked upon as rent for the use of the Town House, they were unreasonable. It seems that £800 is being charged against the Gas and Electricity Departments for such rent. This question was raised a year ago, and, owing to the Scottish Office being satisfied, no further notice was taken of it. The Kirkcaldy gas accounts have also now been made up, and the Gas Department shows somewhat of a loss, as does also the Electric Lighting Department. Of course, this is attributed to the increased price of coal required in both works.

The Edinburgh and Leith Corporations' gas-workers have been in the habit of having an annual excursion and a special day off for the occasion; but the foremen have found it impossible to continue the usual arrangement for this year. Negotiations have taken place with the Gas Commissioners, and it has now been agreed that the men shall have a day added to their ordinary holidays at the trades week, which day they can use for the annual trip if they so desire. A meeting has been held of the Edinburgh Branch of the National Union of Corporation Workers, at which the men agreed to the new arrangement for the present year, but did so without committing themselves to anything definite in the future.

Mr. W. R. Herring is suing the Trustees of the late Mr. Henry Walter Hope, of Luffness, for the sum of £87 for the services alleged to have been rendered by him in laying a new main from the gas-works at Aberlady to Luffness House in 1907-8. The defence raised was that the account was excessively charged, and that a portion of the work done by Mr. Herring was really for the Aberlady Gas Company, and not on the instructions of Mr. Hope or his Trustees. Mr. Herring occupied the witness-box for the whole day, and claimed that the work of examination and reporting upon the gas-works was a necessary part of the work which he was instructed to carry out, and that he thought that Mr. Hope was to all intents and purposes the Gas Company. Sheriff M'Leod indicated that he would have considerable difficulty in the case, and suggested that the parties might, in the interval before next court, consider the possibility of arriving at an agreement. The proof was deferred to July 6.

The Catrine Gas Company, Limited, have held their annual general meeting. The accounts show a net balance, after providing for depreciation and other charges, of £155 15s. 3d., from which a dividend of 2s. per share has been declared; the balance of £71 being placed to the sinking fund. The leakage has been considerably reduced, and the Chairman hopes that by another year there will be a still further improvement. The make of gas has been 9230 cubic feet per ton of coal carbonized. The price of gas was reduced by 5d. per 1000 cubic feet as from the date of the last collection.

The Leslie Gas Company have issued their balance-sheet. This shows a profit of £371, which will permit of a dividend of 10 per cent. (instead of the usual 7½ per cent.), with a balance of £137 to be carried forward. The price of gas here has also been reduced from 3s. 9d. to 3s. 6½d. per 1000 cubic feet.

The Falkirk Town Council Gas Committee have had before them the report of Mr. William Wilson regarding high-pressure gas, and also a supplementary report. These are being considered by a Sub-Committee of four, who will report upon them.

The burgh of Kintore recently obtained a Provisional Order to carry out an electric light undertaking. Everything is now completed, and the light ready to be turned on. A difficulty has arisen, however, as to the exact terms of the lease obtained of the ground by the Town Council from the Kintore Trustees. The former body intended and understood that the lease was to be for 999 years; but the Trustees now hold that the terms were for 99 years only. The matter is in course of adjustment; but meantime the good folk of Kintore must go without their electric light.

The Penicuik Gas Company have recently accepted contracts for steel piping, to be laid with welded joints, and also for the cutting of the track. This pipe will convey the gas under pressure to the village of Roslin, situated about two miles from the gas-works. The Company are also in negotiation with the Roslin District Committee of the Midlothian County Council for a contract for the lighting of the streets. The scheme has been arranged by Mr. Henry O'Connor, and is to be carried out under the supervision of Mr. J. Richmond, the Company's Manager.

**Macclesfield Gas Management.**—A meeting of the Macclesfield Gas Committee has been held to consider the applications received for the position of Engineer and Manager of the gas-works, consequent on the resignation of Mr. William Newbigging. Five candidates were selected to appear before the Committee, members of which are to visit the works where they are at present engaged.


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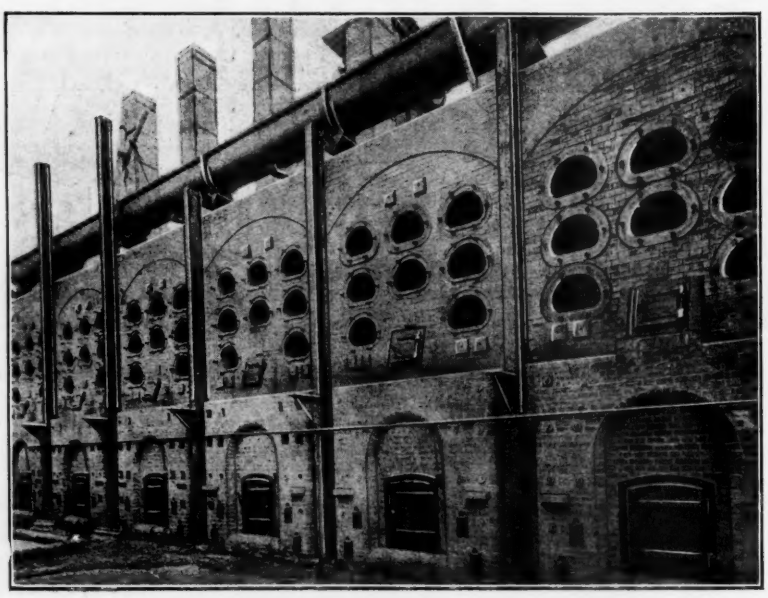

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## CURRENT SALES OF GAS PRODUCTS.

### The London Market for Tar, Tar Products, and Sulphate.

LONDON, *June* 22.

There is practically no change in tar products since the last report; 90 per cent. benzol being 1s. 2d., 90 per cent. toluol 11d., 90-160 solvent naphtha 10¾d., and creosote 3⅞d. to 4d. per gallon—all net and naked. Sixties crude carbolic acid is 1s. 1½d. to 1s. 2d. per gallon net, casks free. Pitch is very inactive, and makers value is 36s. 6d. per ton net.

Twenty-five per cent. sulphate of ammonia has been sold at £10 2s. 6d. net and naked, at makers' works, over the next three months. There is a premium of from 5s. to 7s. 6d. per ton for further forward. The shipments for the first five months of this year prove the correctness of the anticipation that considerably less sulphate would be made by blast-furnaces and coke-ovens this year, owing to the very great slackness in the iron and steel trade. This is another factor that will make for the reaction, which is nearer than some seem to think.

### Tar and Tar Products in the Provinces.

*June* 22.

The average values during the week were: Tar, 24s. 3d. to 28s. 3d. Pitch, east coast, 32s. to 32s. 6d.; west coast, Manchester, 30s. 6d. to 31s. 6d.; Liverpool, 31s. 6d. to 32s. 6d.; Clyde, 31s. 6d. to 32s. 6d. Benzol, 90 per cent., naked, North, 10d. to 10½d.; 50-90 per cent., naked, North, 10d. to 10½d. Toluol, naked, North, 10½d. to 11d. Crude naphtha, in bulk, North, 4⅝d. to 5d. Solvent naphtha, naked, North, 9½d. to 9¾d. f.o.b. Heavy naphtha, naked, North, 9d. to 9½d. f.o.b. Creosote, in bulk, North, 3¼d. to 3⅜d. Heavy oils, in bulk, 3⅜d. to 4⅛d. Carbolic acid, casks included, 60 per cent., prompt, east and west coasts, 1s. 1d. to 1s. 2d. Naphthalene, £4 10s. to £10; salts, 55s. to 60s., bags included. Anthracene, "A" quality, 1½d. to 1⅝d.; "B" quality, nominally, ¾d. per unit, packages included and delivered.

### Sulphate of Ammonia Prices in the Provinces.

LIVERPOOL, *June* 20.

In the early part of the week the market still had a drooping tendency, but towards the close there was an improvement in the demand, and the tone hardened to some extent. New orders from direct buyers have, however, not been plentiful, and the purchasing has been mainly for covering previous sales. The nearest values to-day are £10 7s. 6d. per ton f.o.b. Hull, £10 8s. 9d. per ton f.o.b. Liverpool, and £10 11s. 3d. per ton f.o.b. Leith. There has also been more inquiry for future delivery, and it is reported that £10 12s. 6d. per ton has been paid for July-September, £10 15s. for October-December, and £10 17s. 6d. for January-March, f.o.b. at the ports in equal monthly quantities.

### Nitrate of Soda.

The market for this article remains unaltered, and spot quotations are repeated at 9s. 10½d. per cwt. for ordinary, and 10s. 1½d. for refined quality.

From another source it is reported that there has been no change in sulphate of ammonia during the past week. The market is still very sick for prompt delivery, and it looks as though a fair quantity will be carried forward from this month into next. Outside London, makes are quoted at £9 17s. 6d.; Hull, £10 7s. 6d.; Liverpool, £10 8s. 9d. to £10 10s.; Leith, £10 10s.; Middlesbrough, £10 7s. 6d.

## COAL TRADE REPORT.

### Northern Coal Trade.

The Northern coal trade is disturbed, on the one hand, by the great local holidays, which lessen the production of coal on Tyneside; and, on the other, by the strike of sea-going engineers, which has checked the shipment of coal, though partially and unequally. Prices are rather irregular. In steam coals, best Northumbrians are about 14s. 1½d. per ton f.o.b.; second-class steams are 12s. per ton; and steam smalls are unaltered at 7s. 6d. to 9s. per ton f.o.b. Prices are influenced, however, by the possibilities of early shipment. In the gas coal trade, quotations seem a little easier. Best Durham gas coals are 13s. per ton f.o.b.; second-class kinds are 12s. 1½d. per ton; and "Wear specials" are about 13s. 6d. per ton f.o.b.—exports being fair, where tonnage is available. Contracts are slow in being concluded—one of the Norwegian buyers having taken only a limited quantity for early use, and leaving the bulk of the requirements for future purchase; so that lower prices seem expected by some foreign buyers. Some smaller quantities for home users are being slowly settled, and that at prices a little below those above quoted for gas coals. Coke is steady. There are heavy shipments of gas coke being made from the Tyne. Good gas coke is about 13s. to 13s. 3d. per ton f.o.b.

A special report was presented to the Sedgley Urban District Council last Thursday from the Gas Committee, who pointed out that a deputation from the local branch of the Gas-Workers' Union had waited upon them, and asked for the following increases in wages: Stokers, from 32s. 6d. to 38s. per week; assistants, from 29s. to 34s. per week; and labourers, from 21s. to 23s. per week. Before doing anything in the matter, the Council decided to obtain particulars of the wages paid for similar classes of labour in other gas-works in the locality.


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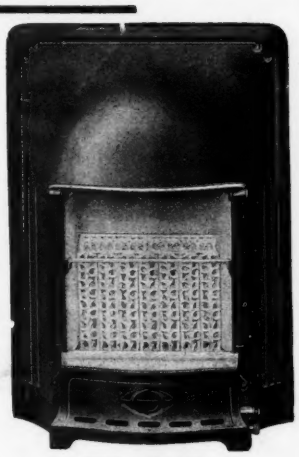

THE "ROSE."

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(See "THE LANCET," 4th April, 1914.)

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## Skipton Gas Undertaking.

The annual statement in connection with the Skipton Gas-Works was presented at a meeting of the Council last week. As compared with a year ago, there was a considerable decrease in the profit arising from carrying on the concern; the sum being £95, as against £1092 a year ago. The difference is accounted for by a reduction in the price of gas, which affected the revenue to the extent of £1132, and by an increase of £725 in the cost of production and supply, due in a large measure to the higher prices paid for coal. The report stated that the outlook for the coming year was not very encouraging. There would certainly be a saving on the coal account; but this would be counterbalanced by the drop in the price of residuals, in addition to which the Committee are pledged to the expenditure of close upon £2000 for a new gasholder. The total output of gas was 100,161,000 cubic feet, as against 102,482,000 cubic feet last year.

## Testing Gas in the Wandsworth District.

The General Purposes Committee of the Wandsworth Borough Council have had under consideration a letter from Dr. H. Wilson Hake, asking for instructions as to carrying out tests of gas at the testing-station at Haydon's Road, Wimbledon, and, in connection therewith, the general question of testing the gas supplied in the borough. At present Dr. Hake's duties are to make tests at the Council's testing-station at Putney of the gas supplied by the Wandsworth, Wimbledon, and Epsom District Gas Company on two days each week at irregular times, with an extra test, without charge, whenever he thinks it desirable; also to make 24 tests per annum at the station at Haydon's Road, and to keep a record of all such tests. His remuneration is £200 per annum. The Committee have decided that the present arrangement should be terminated by three months' notice, and that Dr. Hake be appointed to test the gas in so much of the borough as is supplied by the Wandsworth, Wimbledon, and Epsom Company and the Brentford Company, on the understanding that he makes one test each week at the Haydon's Road station for illuminating power and calorific value, sulphuretted hydrogen, sulphur compounds other than sulphuretted hydrogen, and pressure, and twelve additional tests per annum of the calorific value at each of such stations at irregular times; that he keeps a record of such tests, and furnishes the Council with a fortnightly report thereon; and that he be paid at the rate of £200 per annum, to include assistance and travelling expenses.

**Forthcoming Sale of South Suburban Debenture Stock.**—Messrs. A. & W. Richards announce that they will offer for sale by auction at the Mart, Tokenhouse Yard, E.C., next Tuesday, an issue of £20,000 of 5 per cent. perpetual debenture stock of the South Suburban Gas Company. The sale will also include some shares in the St. Albans Water-Works Company, which rarely come into the market.

## Gas-Workers' Union and Strikes.

A new policy, which has for its object the abolition of strikes and the substitution therefor of the policy of peaceful persuasion by the men's leaders interviewing employers in regard to alleged grievances, has developed in the Manchester district during the past week, states our Manchester Correspondent; and it is hoped that it will continue. As to the Lancashire District of the National Union of Gas Workers and General Labourers, it is said that Mr. J. R. Clynes, M.P., the District Secretary, will vacate his position to become a sort of "General President" of the organization, which, it is understood, means that he will act as adviser-in-chief to the Union. All those who have come in contact with Mr. Clynes during strike negotiations will acknowledge that he has the necessary attributes for such a post. Consequent on Mr. Clynes' promotion—for such it is—a good deal of interest is taken in the appointment of his successor. Mr. Fleming Eccles, the Organizing Secretary, is spoken of; but final arrangements are not yet made.

## Lighting of Clapham Common.

At a meeting of the Wandsworth Borough Council on Friday, Mr. Doland said the lighting of Clapham Common South Side was most inadequate for modern requirements, and proposed that the Lighting Committee be instructed to instal double inverted burners in substitution for the present single burners. He added that the lighting of the whole of the borough was most unsatisfactory, and should be taken into serious consideration. It was very poor when compared with other boroughs. The standards were put up some sixty years ago. Before the amalgamation with Wandsworth, the lighting rate in Tooting was 6d. in the pound; but it had been reduced to 2d. now, because of the cheeseparing policy that had been adopted by the Council with regard to public lighting. The standards averaged 88 yards apart; and, as it was a main thoroughfare out of London, the road was dangerous at night, both to traffic and pedestrians. The extra lighting he suggested would not cost more than £80 per annum. Alderman Lorden said the Committee had viewed the road, and came to the conclusion that it was well lighted when compared with other parts of the borough. The 6d. lighting rate for Tooting was in 1889, when they had no Borough Council to look after them and to limit their expenditure. He proposed that the matter be referred to the Committee for consideration, and to report to the Council. Mr. Mathias said the lighting of the borough was done within a certain price, and beyond this they would not go. They were not prepared to spend any more money on street lighting. The Council decided to send the question to the Committee for consideration and report.

Mr. C. J. Gregg, who has for some years been principal traveller at the firm's Glasgow branch, has been appointed Manager in place of Mr. Gustav Falk, who is leaving to take up his position as Director on the Board of Messrs. Falk, Stadelmann, and Co., Limited, in London.

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## Workmen's Compensation Case at Chichester.

An action against the Chichester Gas Company was heard last Wednesday, in the local County Court; compensation being claimed by George Tadd, who, while an employee, had met with an accident on the Company's works five years ago, injuring his head. After he left Chichester, he had worked for the Worthing Gas Company; and against the defence that the statutory clause of the Act rendered the action void, it was contended that the claimant had been rendered unfit by the accident to previously appear in Court. The Judge, however, negatived the latter view, and expressed an opinion that in such a measure as the Workmen's Compensation Act the statutory limit must be observed. Judgment was thereupon given for the defendants with costs.

## Truro and the Electric Light.

A good deal of attention was bestowed last week on the question of the proposed electric lighting scheme for Truro. The Mercantile Association discussed it on Tuesday, the City Council on Wednesday, and there was a public meeting of ratepayers on Thursday for the purpose of hearing what the Council proposed to do. Mr. S. J. Ingram (the Engineer and Manager of the Gas Company) spoke at the meeting of the Mercantile Association in opposition to the scheme, which he predicted would not prove the financial success which its advocates professed. He was also present at the ratepayers' meeting, and put a number of questions to Dr. Purves, who is the author of the Corporation electricity scheme. Dr. Purves stated that Truro was the only town of its size and importance in the West of England which did not possess electric light, and said that if it was introduced there would no doubt be a reduction in the price of gas, which was now 3s. 11d. per 1000 cubic feet. Mr. Ingram challenged Dr. Purves, to the amount of £5 to go to the funds of the local hospital, if it could be demonstrated by two approved independent experts that the light given by electricity, when consumed in metallic filament lamps, at 6d. per unit, was equivalent to that produced by coal gas costing, not 3s. 6d., but 6s. per 1000 cubic feet, when consumed in inverted burners. Dr. Purves, however, declined the challenge, saying he had no £5 notes to throw away. He, however, adhered to his figures as to the relative cost of the two illuminants.

**The New Carbonizing Plant at Darwen.**—Referring to the erection at Darwen of chamber-ovens on the Munich system, a local paper states that "Darwen's enterprising experiment is being closely followed by municipalities in all parts of the kingdom; and the results will be awaited with much interest." The writer then goes on to say that "Stockport is likely to follow Darwen's lead, and plans for the new system are being got out." It is expected, says our Manchester correspondent, that the Darwen installation will be completed in the early part of October.

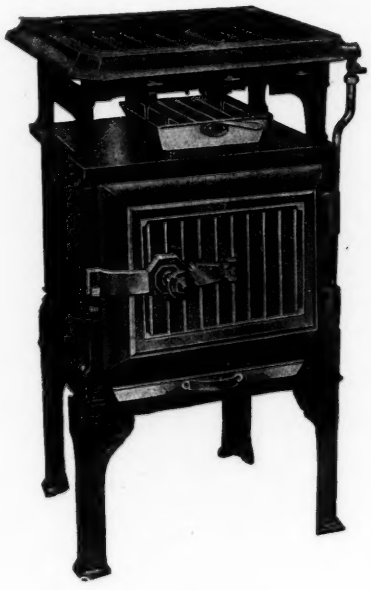
## Registration of Agreements Under the Workmen's Compensation Act.

Last Thursday, Mr. Ellis Hill applied to the Divisional Court, consisting of Justices Lawrence, Avory, and Atkin, on behalf of the Brandon Gas Company, for an order *nisi*, under Section No. 131 of the County Courts Act, in the nature of a *mandamus* directing the Registrar of the Thetford County Court to register a memorandum of agreement under the Workmen's Compensation Act. [The matter was recently referred to, see *ante*, p. 727.] An accident having occurred by which the Manager was injured, the Company were paying the maximum sum due under the Act, and therefore they had a right to have the memorandum registered in the County Court so as to protect them from future proceedings. The Manager was totally disabled, and by an award of the County Court he was granted 19s. per week—the maximum allowed by the Act. The Company agreed with the workman to redeem the weekly payments, and, as authorized by the Act, purchased an annuity and forwarded the memorandum to the Registrar for registration. The Registrar had power to refuse registration if he considered that the amount was inadequate or that the memorandum was not genuine. Mr. Justice Lawrence asked what was the ground of refusal to register. Mr. Hill said he believed it was because the money had not been paid into Court. The Act did not require payment into Court. The Registrar referred the case to the Judge apparently on no particular point, and the Judge decided that the Registrar was right. The Company's contention was that it was the duty of the Registrar, in the absence of any dispute as to the genuineness of the agreement, to record the memorandum as the Act and the rules prescribed. The Registrar did not suggest that there was any ground for not registering the document. Their Lordships granted a rule *nisi*.

**Gas-Works Accident at Birmingham.**—Last Thursday, Sydney Williamson met with a somewhat serious accident while following his employment at the Nechells Gas-Works. It appears that he slipped between an electric lift and a beam, with the result that he sustained fractured ribs and other internal injuries, and was removed to the Birmingham General Hospital.

**Meter Robber's Extraordinary Record.**—At the Tower Bridge Police Court last Tuesday, before Mr. Cecil M. Chapman, Bertrand Hassan, 33, a fitter, of no fixed abode, pleaded "Guilty" when charged on his own confession with stealing 6s. 2d. from a prepayment gas-meter at 50, Stamford Street, Blackfriars, in a room occupied by his stepmother, who stated that he had been a source of trouble since he was thirteen years of age. He had been in Dr. Barnardo's Homes, and had been to the Salvation Army and to the Church Army. He went to Canada, but the Canadian police compelled Dr. Barnardo's people to bring him home. He had robbed his younger brother of his clothes, and had robbed his father. The Magistrate: I shall remand him in the hope that he may be dealt with as morally defective. There is clearly something wrong with him.


# PARKINSON'S "BONNIE"



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## Sale of Stocks and Shares.

Among the stocks and shares offered for sale by auction by Messrs. A. & W. Richards at the Mart, Tokenhouse Yard, E.C., last Tuesday were two new issues of capital. In the Rochester, Chatham, and Gillingham Gas Company, £5800 of consolidated ordinary stock was sold at from £97 to £100 per £100. It ranks for a standard dividend of 5 per cent., subject to the sliding-scale, equally with existing similar stock, now receiving 5⅛ per cent. per annum. In the Brentwood Gas Company, £1000 of 5 per cent. preference stock realized from £101 to £101 10s. per £100; while £975 of additional stock (ranking for a standard dividend of 7 per cent., subject to the sliding-scale, equally with existing stock, now receiving this amount) was sold at from £127 to £128 per £100. From £90 to £91 per cent. was realized for £600 of 4 per cent. perpetual debenture stock in the Broadstairs Gas Company, and from £112 to £113 per cent. for a like amount of 5 per cent. ordinary (1901) stock in the South Essex Water-Works Company.

We have received from the Welsbach Light Company, Limited, of King's Cross, W.C., the new street lighting catalogue they have just issued. It contains a large number of new designs in lanterns, lamps, cluster burners, and conversion sets; and the endeavour has been to make it as complete as possible. The illustrations are very effective, and the catalogue, apart from its special value, will prove interesting to all who are associated with high and low pressure gas lighting.

The Four-Coin Meter Company, of Leith, inform us that Mr. C. Millar Heron has been appointed their representative.

The Workington Iron and Steel Company, Limited, have given notice to the Harrington Coke-Ovens, Limited, that they will acquire from July 1, 1915, the whole of the undertaking, including a hundred bye-product coke-ovens. This action is in accordance with the terms of the agreement that was provisionally come to when Coke-Ovens, Limited, was formed.

Messrs. Ashmore, Benson, Pease and Co., Limited, of Stockton-on-Tees, have received an order from the Croydon Gas Company for a four-lift gasholder, 223 feet diameter by 44 ft. 9 in. deep (with guide-framing rising about 178 feet high), for their Waddon works. The firm have also an order from the European Gas Company for four purifiers, 29 ft. 6 in. square by 6 ft. 7 in. deep, with lifting gear, 20-inch valves and connections, &c., for the Boulogne Gas-Works.

The proposed public water supply for Liphook (Hants) has again been discussed by the Rural Authority at Petersfield, on receiving a report as to prices of land best calculated to furnish an ample supply of water from springs or wells. Some dissatisfaction was expressed that the voice of the Liphook ratepayers had not been officially heard on the subject; and on a division for a poll there were four on each side. The Chairman, however, gave his casting vote for proceeding with the local scheme, as against obtaining a supply from the Wey Valley Water Company; and the Clerk was instructed to enter into negotiations for the acquisition of a site.

# GAS COMPANIES IN THE STOCK EXCHANGE.

The week just closed on the Stock Exchange was an improvement on its predecessor in one respect. Not that business showed any sign of recovery; for it was, if possible, more deadly quiet than ever. But it was that markets as a rule held on pretty firmly, despite the imminent and uncertain solution of the Ulster problem, and the threatening tangle of affairs in Eastern Europe with all its possibilities for mischief. The *point d'appui* lay in the Money Market and the accumulated gold, of which a goodly proportion must demand the market investment which it cannot find in trade. The working of this was conspicuous in the choicest of gilt-edged, and Consols scored the large advance of 1¼. The opening on Monday was very quiet, and business was repressed all day. There was no pronounced weakness in any special line, but a general attitude of caution prompting inaction, and resulting in minor uneven movements. Government issues were mostly lower; but Consols rose ⅛ for the account. In Rails there were some small ups and downs. Transatlantics were slightly lowered by Continental sales. Tuesday was sluggish and apathetic. Nothing could stir the stagnancy but the appearance of anything coming along on offer, and then the price was dropped. Consols gained ⅛ for money; but Rails were apprehensive and lower. Transatlantics were chiefly weaker, and Foreign showed weak spots. Wednesday continued very inactive; but things were inclined to be cheerful at easy money, with a better aspect of the French financial situation, and a rather less gloomy view of Ulster. Government issues were stronger, and Consols rose ¼. Some Rail prices were moderately higher. Thursday was much better. Business looked as if it were going to speed-up a bit; and the tendency was cheered by Paris events, and the continuous cheapening of money. Consols jumped ⅛ for money and ⅝ for the account. Rail prices were better throughout, and Foreign were firm; but Americans were not so good. Friday was also a good day, and business was a shade less inactive; the general tone being quite bright. The further cheapening of money helped Government issues up, and Consols rose ⅜ for money and ⅛ for the account. Rails were uneven, there being some realization; but Transatlantic and Foreign were quite right. Saturday was very quiet; the general attitude being to "wait and see" further moves in Ulster and in the Ægean. Consols touched 74⅞, and closed at 74⅝ to 74⅞. The rest were little moved either way. In the Money Market, rates steadily declined. Business in the Gas Market was better—something more nearly approaching the average as things go nowadays. There was hardly any variation in quotations, the general tendency being very firm. In Gas Light and Coke issues, the ordinary was moderately dealt in at steady figures ranging from 101⅜ to 102½. In the secured issues, the maximum changed hands at 77½ to 78¾, the preference at 97, and the debenture at 73. South Metropolitan were very quiet at 110½ to 111; and the debenture made 75 and 75½. In Commercials, the 4 per cent. realized 107 and 107¼, and the 3½ per cent. 103¾. Among the Suburban and Provincial group, Brentford old fetched 263½ and 264, British 44⅛, South Suburban 114½, Tottenham "B" 115½ and 116½, and Wandsworth "C" 112 and 112½. In the Continental companies, Imperial was one lower at 160 to 165½, ditto debenture marked 85⅝ and 86, Union 78, and ditto preference 116. Among the undertakings of the remoter world, Bombay made 6, Primitiva 5¼, ditto preference 5 and 5⅛, and San Paulo preference 10⅛ and 10 5/16.

## OFFICIAL QUOTATIONS AT THE CLOSE OF THE WEEK.

Bank Rate (fixed January 29), 3 per cent. Last year, 4½ per cent. Consols, 74⅝—74⅞. Previous week, 73⅝—73⅞.

| Issue. | Share. | When ex-Dividend. | Dividend or Dividend & Bonus. | NAME. | Closing Prices. | Rise or Fall in Wk. | Yield upon Investment. |
|---|---|---|---|---|---|---|---|
| £ | | | p.c. | | | | £ s. d. |
| 1,551,868 | Stk. | April 8 | 2½ | Alliance & Dublin Ord. | 61—66 | .. | 3 15 9 |
| 374,000 | ,, | Jan. 15 | 4 | Do. 4 p.c. Deb. | 73—81 | .. | 4 12 9 |
| 280,000 | 5 | April 29 | 7½ | Bombay, Ltd. | 5¼—6⅜ | .. | 5 17 8 |
| 50,000 | 10 | Feb. 26 | 16 | Bourne-mouth Gas and Water — 10 p.c. | 29 - 30 | .. | 5 6 8 |
| 352,500 | 10 | ,, | 7 | Pref. 6 p.c. | 15 –15½ | .. | 4 10 4 |
| 75,000 | 10 | ,, | 6 | | 13½—14 | .. | 4 5 9 |
| 380,000 | Stk. | Feb. 26 | 14 | Brentford Consolidated | 260—265 | .. | 5 5 8 |
| 330,000 | ,, | ,, | 11 | Do. New | 204—209 | .. | 5 5 8 |
| 50,000 | ,, | ,, | 5 | Do. 5 p.c. Pref. | 109—111 | .. | 4 10 1 |
| 206,250 | ,, | June 11 | 4 | Do. 4 p.c. Deb. | 91—93* | .. | 4 6 0 |
| 217,380 | Stk. | Feb. 26 | 11 | Brighton & Hove Orig. | 207—212 | .. | 5 3 9 |
| 244,200 | ,, | ,, | 8 | Do. A Ord. Stk. | 153—158 | .. | 5 1 3 |
| 530,000 | 20 | Mar. 26 | 12½ | British | 44—45 | .. | 5 11 1 |
| 120,000 | Stk. | Dec. 30 | 4 | Do. 4 p.c. Deb. Stk. | 90—92 | .. | 4 7 0 |
| 245,771 | Stk. | ,, | 4 | Buenos Ayres 4 p.c. Deb. | 89—91 | .. | 4 7 11 |
| 100,000 | 10 | — | — | Cape Town & Dis., Ltd. | 1⅛ - 2⅛ | .. | — |
| 100,000 | 10 | — | — | Do. 4½ p.c. Pref. | 4 6 | .. | — |
| 100,000 | Stk. | Dec. 30 | 4½ | Do. 4½ p.c. Deb. Stk. | 73—78 | .. | 5 15 5 |
| 157,150 | Stk. | Feb. 26 | 5 | Chester 5 p.c. Ord. | 10²—110 | .. | 4 10 11 |
| 1,513,280 | Stk. | Feb. 12 | 5/9/4 | Commercial 4 p.c. Stk. | 106—108 | .. | 5 1 2 |
| 560,000 | ,, | ,, | 5½ | Do. 3½ p.c. do. | 103½ - 105½ | .. | 5 1 1 |
| 475,000 | ,, | June 11 | 3 | Do. 3 p.c. Deb. Stk. | 69½—71½* | .. | 4 3 11 |
| 800,000 | Stk. | ,, | 4 | Continental Union, Ltd. | 78—81* | .. | 4 18 9 |
| 200,000 | ,, | ,, | 7 | Do. 7 p.c. Pref. | 113½–116½* | –1 | 6 0 2 |
| 492,270 | Stk. | — | 6 | Derby Con. Stk. | 123—125 | .. | 4 16 0 |
| 55,000 | ,, | — | 4 | Do. Deb. Stk. | 102—104 | .. | 3 16 11 |
| 1,002,180 | 10 | Jan. 15 | 10 | European, Ltd. | 18—18½ | .. | 5 8 1 |
| 16,386,660 | Stk. | Feb. 12 | 4 17/4 | Gas — 4 p.c. Ord. | 101—103 | .. | 4 14 7 |
| 2,600,000 | ,, | ,, | 3½ | Light — 3½ p.c. max. | 76—79 | .. | 4 8 7 |
| 4,062,235 | ,, | ,, | 4 | and — 4 p.c. Con. Pref. | 96—99 | .. | 4 0 10 |
| 4,674,850 | ,, | June 11 | 3 | Coke — 3 p.c. Con. Deb. | 72—74* | .. | 4 1 1 |
| 258,740 | Stk. | Mar. 12 | 5 | Hastings & St. L. 3½ p.c. | 87- 89 | .. | 5 12 4 |
| 70,000 | 10 | April 29 | 11 | Hongkong & China, Ltd. | 16½–16⅝ | .. | 6 11 4 |
| 131,000 | Stk. | Mar. 12 | 7⅛ | Ilford A and C | 151—154 | .. | 4 19 0 |
| 65,780 | ,, | ,, | 6½ | Do. B | 115—118 | .. | 5 3 10 |
| 65,500 | ,, | Dec. 30 | 4 | Do. 4 p.c. Deb. | 94—96 | .. | 4 3 4 |
| 4,940,000 | Stk. | May 14 | 9 | Imperial Continental | 161—166 | –1 | 5 8 5 |
| 1,235,000 | Stk. | Feb. 12 | 3½ | Do. 3½ p.c. Deb. Red. | 84—86 | .. | 4 1 5 |
| 200,242 | Stk. | Mar. 12 | 6½ | Lea Bridge Ord. 5 p.c. | 119—121 | .. | 5 7 5 |
| 561,000 | Stk. | Feb. 26 | 10 | Liverpool United A | 210—212 | –1 | 4 14 4 |
| 718,100 | ,, | ,, | 7 | Do. B | 144—146 | .. | 4 15 11 |
| 306,083 | ,, | Dec. 30 | 4 | Do. Deb. Stk. | 99—101 | .. | 3 19 8 |
| 63,480 | Stk. | Dec. 30 | 3 | Maidstone 3 p.c. Deb. | 65—67 | .. | 4 9 7 |

| Issue. | Share. | When ex-Dividend. | Dividend or Dividend & Bonus. | NAME. | Closing Prices. | Rise or Fall in Wk. | Yield upon Investment. |
|---|---|---|---|---|---|---|---|
| £ | | | p.c. | | | | £ s. d. |
| 75,000 | 5 | June 11 | 6 | Malta & Mediterranean | 4½–4⅝* | .. | 6 9 9 |
| 250,000 | 100 | April 1 | 4½ | Met. of Melbourne — 4½ p.c. Deb. | 99 –101 | .. | 4 9 1 |
| 541,920 | 20 | May 28 | 4 | Monte Video, Ltd. | 11⅜—12½ | .. | 6 13 1 |
| 1,775,892 | Stk. | Feb. 26 | 4½ | Newc'tle&G'tesh'd Con. | 9⅜—10⅜ | .. | 4 9 7 |
| 529,705 | Stk. | Dec. 30 | 3½ | Do. 3½ p.c. Deb. | 83½—84½ | .. | 4 2 10 |
| 55,940 | 10 | Feb. 26 | 7/14/0 | North Middlesex 7 p.c. | 14—15 | .. | 5 2 8 |
| 300 000 | Stk. | May 14 | 8 | Oriental, Ltd. | 117—122 | .. | 6 11 2 |
| 60,000 | 5 | Mar. 26 | 10 | Ottoman, Ltd. | 7⅛—7⅜ | .. | 6 9 0 |
| 60,000 | 50 | Feb. 26 | 13 | Portsea, Island B | 128—131 | .. | 4 19 3 |
| 100,000 | 50 | ,, | 12 | Do. C | 118—121 | .. | 4 19 2 |
| 249,980 | 5 | April 29 | 8 | Primitiva Ord. | 5⅜—6⅛ | .. | 6 8 0 |
| 499,960 | 5 | Dec. 30 | 5 | ,, 5 p.c. Pref. | 5—5⅛ | .. | 4 15 8 |
| 521,600 | 100 | June 2 | 4 | ,, 4 p.c. Deb. | 91—94 | .. | 4 6 0 |
| 346,198 | Stk. | Dec. 30 | 4 | River Plate 4 p.c. Deb. | 87—89 | .. | 4 9 11 |
| 150,000 | 10 | May 14 | 6 | San Paulo — 6 p.c. Pref. | 10½—11 | .. | 5 9 1 |
| 125,000 | 50 | Jan. 2 | 5 | — 5 p.c. Deb. | 48 - 50 | .. | 5 0 0 |
| 135,000 | Stk. | Mar. 12 | 10 | Sheffield A | 223—224 | .. | 4 9 8 |
| 209,984 | ,, | ,, | 10 | Do. B | 222—224 | .. | 4 9 3 |
| 523,500 | ,, | ,, | 10 | Do. C | 222—224 | .. | 4 9 3 |
| 90,000 | 10 | May 28 | 9 | South African | 10½—11½ | .. | 7 16 6 |
| 6,429,895 | Stk. | Feb. 12 | 5/9/4 | South Met., 4 p.c. Ord. | 109—111 | .. | 4 18 6 |
| 1,895,445 | ,, | Jan. 15 | 3 | Do. 3 p.c. Deb. | 74—76 | .. | 3 18 11 |
| 209,820 | Stk. | Feb. 26 | 8½ | South Shields Con. Stk. | 157—159 | .. | 5 6 11 |
| 952,795 | Stk. | Feb. 26 | 6 | S'th Suburb'n Ord. 5 p.c. | 114—116 | .. | 5 3 5 |
| 60,000 | ,, | ,, | 5 | Do. 5 p.c. Pref. | 110—112 | .. | 4 9 3 |
| 117,058 | ,, | Dec. 30 | 5 | Do. 5 p.c. Deb. Stk. | 113—115 | .. | 4 6 11 |
| 629,740 | Stk. | May 14 | 5 | Southampton Ord. | 99—102 | .. | 4 18 0 |
| 120,000 | Stk. | Feb. 12 | 7⅜ | Tottenham District — A 5 p.c. | 135—138 | .. | 5 6 10 |
| 543,940 | ,, | ,, | 5⅝ | — B 3½ p.c. | 115—117 | .. | 5 0 5 |
| 149,470 | ,, | Dec. 30 | 4 | — 4 p.c. Deb. | 89—91 | .. | 4 7 11 |
| 182,380 | 10 | ,, | 5 | Tuscan, Ltd. | 5—6 | .. | 8 6 8 |
| 149,900 | 10 | Jan. 2 | 5 | Do. 5 p.c. Deb. Red. | 95—97 | .. | 5 3 1 |
| 236,476 | Stk. | Mar. 12 | 5 | Tynemouth, 5 p.c. max. | 108½–109½ | .. | 4 11 4 |
| | | | | Wandsworth, Wimbledon, and Epsom— | | | |
| 30,000 | Stk. | Feb. 26 | 8⅜ | Wandsworth A 5 p.c. | 151—156 | .. | 5 7 4 |
| 255,636 | ,, | ,, | 6⅞ | ,, B 3½ p.c. | 129—134 | .. | 5 2 7 |
| 108,075 | ,, | ,, | 5/17/8 | ,, C 3½ p.c. | 110—115 | .. | 5 2 0 |
| 352,000 | ,, | ,, | 6¼ | Wimbledon 5 p.c. | 117—122 | .. | 5 0 5 |
| 98,000 | ,, | ,, | 6⅝ | Epsom 5 p.c. | 121—126 | .. | 5 5 2 |
| 88,416 | ,, | Dec. 30 | 3 | 3 p.c. Deb. Stk. | 68—71 | .. | 4 4 6 |

Prices marked * are "Ex Div."